MARCH 1957

Power Engineering

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Circulation of This Issue 40,610

Keeping pace with modern

These two Elliott turbine-generator units are located in an interesting new central station which was completed at a station cost of $139 per kw! The turbines operate on steam at 850 psi, 900°F. Both machines are base loaded, part of the power production being used for a local distribution system and the surplus sold as block power through a transmission interchange.

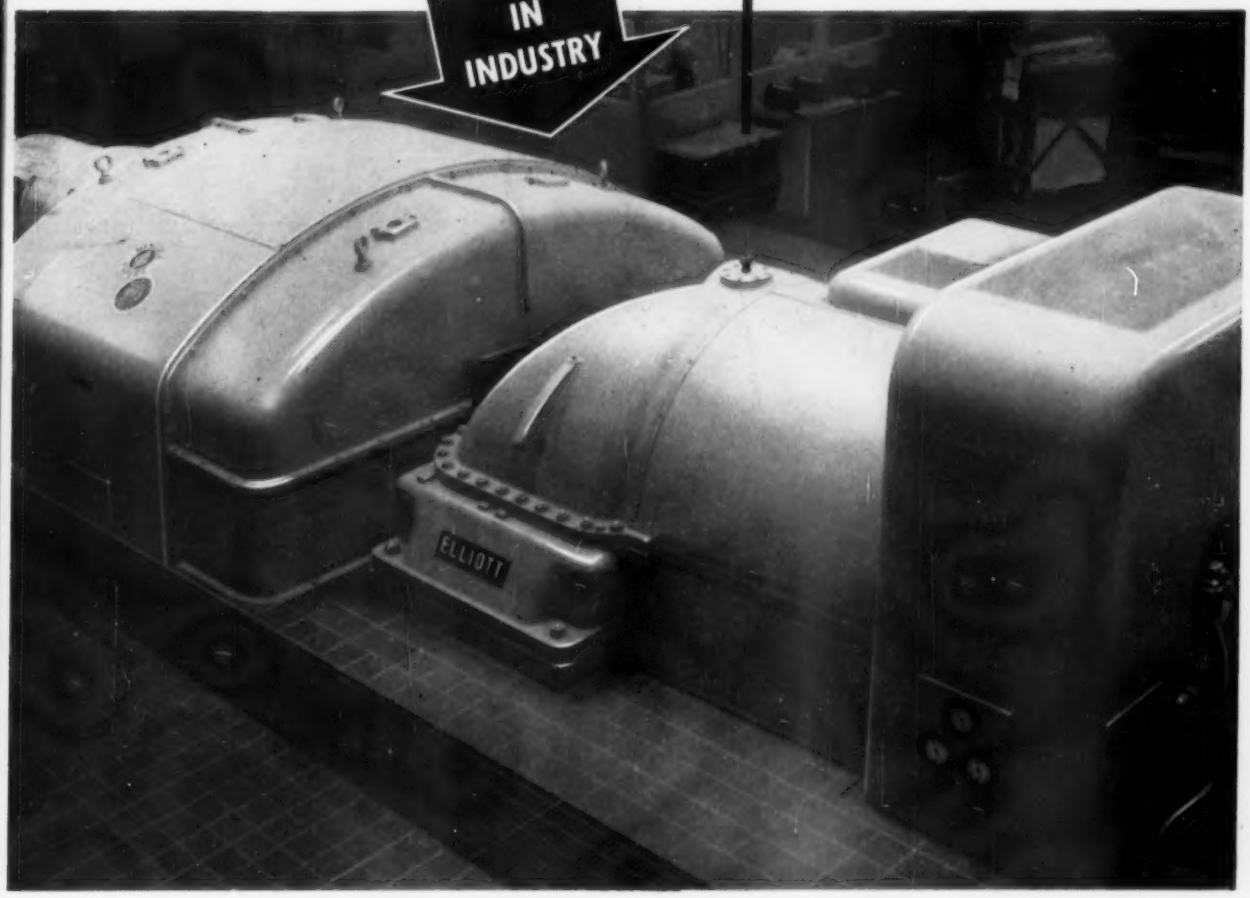
ELLIOTT TURBINE-GENERATORS

H4-5

requirements

IN INDUSTRY

This Elliott turbine-generator unit serves an industrial power plant. It extracts steam for process at 30 psig, being supplied with 400 psig, 700°F steam. This unit is an extension to an existing industrial power plant served by an Elliott back-pressure extraction unit.



ELLIOTT TURBINE-GENERATORS meet the requirements for efficient power generation in utility stations, and the balanced power and process steam requirements of industrial plants. Their modern appearance is indicative of their sound design and superior performance. Both the steam and electrical elements are made by Elliott and the result is a coordinated unit, specifically designed to the individual needs of the plant or station.

New Engineering Bulletin...

"Fundamentals of Turbine Speed Control" contains 32 pages of the latest information on this important aspect of turbine design and performance. Write for Bulletin H-21 to the Elliott Company, Steam Turbine Department, Jeannette, Pa.

ELLIOTT Company

TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

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In POWER STATIONS or CARGO SHIPS...

EDISON OMNIGUARD IMPROVES OPERATING EFFICIENCY

Whether you're seeking more production from electric power stations and plant equipment or greater safe speed from seagoing vessels, you will find Omniguard can help you get more efficiency from your present equipment.

Many operators are already using Omniguard, the unique temperature indicating and alarm system designed by Thomas A. Edison, Inc., as the best means of eliminating waste due to downtime, repairs and lost production.

Omniguard improves plant efficiency and lets you operate at peak capacity because it unfailingly reports when dangerous temperature conditions occur at one or more points. And does it at surprisingly low cost.

A modular system of monitoring one to an unlimited number of points simultaneously, Omniguard watches continuously. When a bearing starts heating up or a process becomes critically hot, it automatically gives a warning and/or shuts down the equipment before it is damaged.

The low cost unit is easy to install. It is non-electronic and simplifies installation and maintenance through the use of copper wiring between all components.

See for yourself. A personal demonstration can be arranged at your own plant. Take it apart. Analyze it. Find out how simply Omniguard improves operating efficiency. Just write!

Thomas A Edison

A GREAT NAME CONTINUES GREAT NEW ACHIEVEMENTS

Thomas A. Edison

INCORPORATED

INSTRUMENT DIVISION • 97 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY

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NBP BPA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

BLANKETING fog of over-precise, cliché-loaded technical jargon that characterizes much of today's technical copy is under attack by one of the pioneering firms in automation.

Minneapolis-Honeywell, automatic control maker and thus deeply steeped in engineering, has embarked on a program for good, clear (even un-precise) English! It states its platform in a recently published compact handbook for its technical writers, forthrightly entitled Why Not Just TELL Them?

Down-to-earth tips on how to sharpen and polish technical writing are found under such headings as Overstuffed Sentences, Cliches That Clutter, and The Headline Is The Bait.

But what may be the cornerstone for better technical writing and reporting is found in the booklet's Ten Commandments For Technical Writing. A separate section contains expanded notes on these commandments. There are also sections on engineering abbreviations and on compound technical words.

This 25-page, letter-envelope-size booklet is being distributed to the firm's technical copy writers, editorial writers and technical reporters in 10 divisions. If you can use a copy of it, write the *Engineers' Preview* editor.

SHOULD Your Child Be an Atomic Scientist? Lawrence R. Hafstad, vice president in charge of the Research Staff of General Motors Corp, urges parents of the youngster "with a scientific gleam in his eye" to encourage their child to prepare for a career in the nuclear science field.

Expanding technical horizons in industry, government, universities and private foundations, Mr. Hafstad says, will require many thousands of atomic science recruits within the next few years. He advises today's science students to steep themselves in the fundamentals of the field. At the same time he warns that atomic science is not a calling for the average student. He cites as qualifications for success in the field an above-average mathematical aptitude imagination, intellectual curiosity, patience and a willingness to keep trying; a capacity for hard work, an ability to collect data, organize facts and analyze them, and the willingness to be a non-conformist — to get off well-traveled mental highways and strike out for oneself.

GLENN B. WARREN, vice president of the General Electric Co, was appointed Consulting Engineer, Turbine Division, on January 1, to help

Glenn B. Warren

William S. Ginn

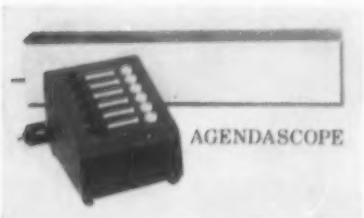
provide the engineering skill and leadership needed to meet the nation's rapidly expanding electrical power requirements. In his newly-created post, Mr. Warren will devote full time to accelerating the technical progress of industry's basic power unit, the turbine generator. He will be responsible for formulating and establishing long-range engineering and product plans for all departments of the company's Turbine Division, as well as for conducting a continuous audit of all related engineering activities.

"The rising cost of fossil fuels, the rapid industrialization taking place all over the world, and the electrification of the home-all combine to make the fulfillment of future power needs of vital impact on social and economic progress," said GE Vice-President Paxton in announcing the appointment.

Mr. Warren's former duties as general manager of the Turbine Di-

vision were assumed Jan. 1 by Vice President William S. Ginn. Mr. Ginn has been general manager of General Electric's Transformer Division in Pittsfield, Mass. Raymond W. Smith succeeds Mr. Ginn as general manager of the Transformer Division on that date. Mr. Smith was formerly general manager of the Distribution Transformer Department, a component of the Transformer Division.

NEW CONCEPT in aids for public speakers is the Agendascope, a brown, crinkle-finish, inconspicuous unit that fits on the top of a lectern and permits the chairman of a meeting to flash any one or a combination of six different messages to the speaker while he is speaking.


AGENDASCOPE

It is 18 in. long by 4 in. high and only 2 in. deep, made of light metal, with a translucent plastic face plate. It is operated by the meeting chairman or an assistant seated in the audience. A small central panel, with six push buttons, enables the operator to turn on the light in any one of the six compartments in the Agendascope in front of the speaker.

As the light goes on, in the Agendascope, the message, which up to this point had been invisible, on the inside surface of the plastic face, is sharply and clearly silhouetted in large letters, six times the size of ordinary typewriter type.

Messages on standard Agendascope are:

SPEAK LOUDER, PLEASE—YOU ARE TOO CLOSE TO THE MICROPHONE—YOU ARE TOO FAR FROM THE MICROPHONE—YOU HAVE FIVE MINUTES LEFT—YOU HAVE ONE MINUTE LEFT—SORRY, YOUR TIME IS UP.

The unit, complete with carrying case, is priced at $98.50.

COAL and Ash Storage and Handling for boiler plants using up to 5000 tons of coal annually has just been released by Bituminous Coal Research, Inc.

Effectiveness of the heating equipment of a plant is directly dependent upon a steady flow of coal from the supplier to the coal storage area of the building and from there to the boiler in which the coal is burned.

Coal storage and handling facilities for the boiler plant using up to 5000 tons of coal per year can be made automatic by careful design and placement of storage bins and selection of proper conveying equipment.

Size of these plants is such as to preclude the cost of complicated material handling equipment because of the high capital cost. However, with proper design and location of the storage areas and provision for the movement of coal and ash by means of low-cost mechanical devices, reliable automatic operation with minimum attention and low operating cost can be obtained.

The booklet presents detailed suggestions for bin filling methods, transfer of coal from bin to stoker by bin feed stoker and stoker hopper feeder, storage bin capacity, bin construction, ash handling and storage, and factors affecting bin capacity. Formulas and designs for computing bin capacity for both bin feed stokers and stoker feeders are also presented. Six typical plant layouts are included.

Coal and Ash Storage and Handling can be obtained at 35 cents per copy from Bituminous Coal Research, Inc, 121 Meyran Ave at Forbes St, Pittsburgh 13, Penna.

AMERICAN SOCIETY for Testing Materials announces that it has just issued 1956 Supplements to its 1955 Book of ASTM Standards, which is issued triennially.

Part 1. Ferrous Metals — 440 pages
Part 2. Non-Ferrous Metals — 360 pages
Part 3. Cement, Concrete, Ceramics, Insulation, Road Materials and Waterproofing — 300 pages
Part 4. Paint, Naval Stores, Woods, Building Constructions, Fire Tests, etc. — 230 pages
Part 5. Fuels, Petroleum, Hydrocarbons, Antifreezes — 320 pages
Part 6. Rubber, Plastics, Electrical Insulating Materials — 380 pages
Part 7. Textiles, Soap, Water, Paper, Adhesives, Shipping Containers, Atmospheric Analysis — 220 pages

These 1956 Supplements, in heavy paper covers, can be obtained from the American Society for Testing Materials, 1916 Race St, Philadelphia 3, Penn., at $4 per part — or $28 for the complete set.

We Are Looking for Editors

POWER ENGINEERING is expanding and will have openings for graduate engineers in the mechanical or electrical field with a good solid background of operating, design, and construction experience. If you like to travel, meet people, learn of new developments, investigate new ideas, and if you have imagination, ingenuity and tact, together with a reasonable command of English, you will find this interesting work. There are several openings on the editorial staff, but the immediate one has the following specifications:

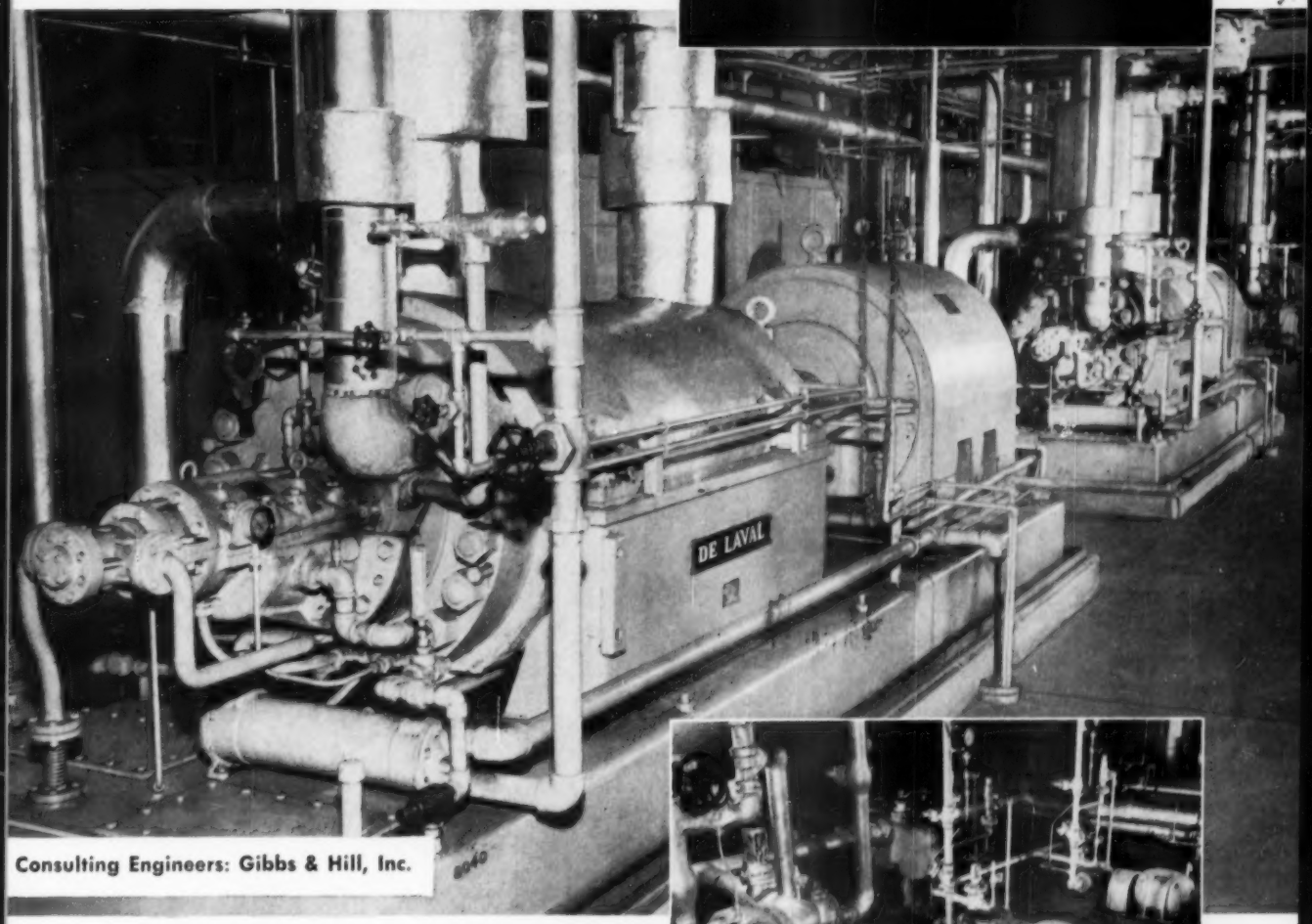
A graduate engineer from 45 to 50 years of age, who has gone through a cadet or student engineer's course with one of the public utilities, spent a number of years in the operating department, two or three years in the power sales department, and a number of years as power engineer with industrial companies, and who holds a professional engineer's license.

Another opening could be filled by a graduate engineer about 30 years old, with good grounding in engineering fundamentals, and particularly in heat power engineering. Subsequent to graduation, he should have had several years of work in a utility or industrial power plant, or in an industry having diversified steam and electrical problems.

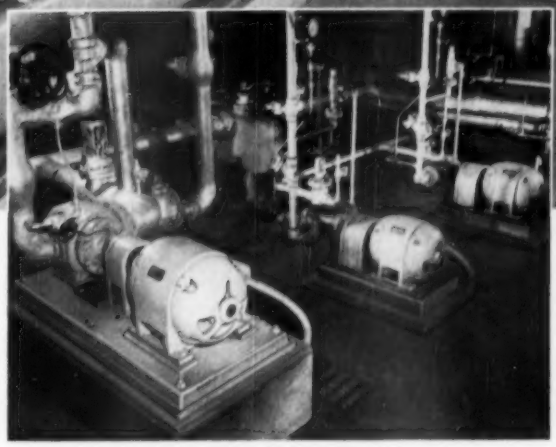
If you meet all or many of the above specifications and are interested in the above jobs, send complete details of your education and experience to Editor of POWER ENGINEERING, 110 So. Dearborn St., Chicago, Ill. Mark your letter Personal or Confidential.

Atlantic City Electric ... another utility using

DE LAVAL
BARREL TYPE BOILER FEED PUMPS



Consulting Engineers: Gibbs & Hill, Inc.



De Laval IMO rotary positive displacement pumps handle heavy fuel oil. They are used for standby operation.

Atlantic City Electric Co. and Gibbs & Hill, Inc., Consulting Engineers, know that they can count on De Laval reliability. That's why they selected three De Laval high pressure barrel type boiler feed pumps for the Deepwater Station in Penns Grove, New Jersey. These 10-stage units deliver 675 gpm, operating at 1762 psi with temperature at 287 F. The pumps are driven by 900 hp motors.

De Laval barrel type boiler feed pumps operate at pressures up to 5500 psi. These units offer many important design advantages, such as double volute diaphragm, individual diaphragm bolting, only one inner high-pressure joint, and bare shaft construction. Their dependability is proven by year in, year out service in public utilities and industrial plants.

Send for De Laval Bulletin 1506, which contains helpful data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY
816 Nottingham Way, Trenton 2, New Jersey

943

WHAT THEY TELL US

▶ **IN THE OCTOBER** issue Henry Sousa said he had a problem in his hospital. He asked for information on sewer traps or methods of trapping plaster of paris in the cast room of his hospital to prevent the plaster from plugging up the drains and sewer lines.

The solution is somewhat simpler than you might suppose. Here it is, as offered by William D. M. Snell, Superintendent of Building Services and Maintenance of the world-famous Presbyterian — St. Luke's Hospital here in Chicago:

> We are going through much the same problem ourselves, but we have solved it by using a plaster trap and sink combination with great success. These items can be obtained from most well-established industrial or hospital supply firms.
>
> One of the leading manufacturers of piping and sanitary equipment gives a listing of this equipment in its hospital service catalog. I recommend that Mr. Sousa contact a representative of either this company or one of the others in that field and I believe his troubles will be over.

Many thanks for the prompt and specific help, Mr. Snell.

▶ **EXTENT** of the industrial upsurge in South America is brought to our attention by a recent letter from J. H. Hunnicutt, author of the series of articles on power plant start-up, published in the December, January and February issues of POWER ENGINEERING. We found his comments colorful, and thought we would pass some of them on to you:

> . . . How can I begin to describe a country that far surpasses the old saw of being an enigma within a riddle? . . . This is more in the category of a dilemma within a quandary within a just-can't-be-so-but-is.
>
> . . . Caracas: A city of jewels, Parisian gowns and furs (in this super-tropical atmosphere, *Furs!*); of more topnotch French, Italian, German, and Hungarian restaurants and bistros than New York City. Oh yes, and one American-style hamburger joint that does a roaring 20-hour-a-day business! Of luxurious gardens and parks and beautiful government subsidies to all forms of art and culture.
>
> A city of fabulous wealth and abysmal poverty, and a good portion of each with not much in between except a sprinkling of us technical-know-how foreigners.
>
> . . . A word to the wise: Do not speak harshly to the boot-black or the garbage collector, lest tomorrow he awake with the wherewithal and in his umbrage buy your company and have you polishing floors. He may then build a beautiful Venezuelan (remember, that means Little Venice) chateau of native marble, full of Antwerpian drapes and Florentine period furniture (of Venezuelan mahogany) loaded to the hilt with French, Italian, and Spanish objets d'art and a dozen baths replete with inlaid mosaic and completely walled with mirrors.

Author Hunnicutt complains his letter was written on a German Remington that "doesn't write English worth a toot!" However, receiving his letter during a period of typical Chicago winter, along with sub-zero temperatures, the feeling of warmth and lushness it conveyed made us very unhappy.

▶ **TAKING EXCEPTION** to parts of the article: Boiler Water Chemical Treatment, by C. B. Scharp in our February 1956 issue, Directing Chemist W. L. Denman of Dearborn Chemical Co took pen in hand and wrote us as follows:

> In this article, it is stated that: "The filming amines are primarily applicable to pressures below about 200 psig. At higher pressures these organic amines tend to break down which can deposit hydrocarbon tars over the metallic surfaces." This statement not only is very general but also is *mis*leading and contrary to facts.
>
> On the basis of the paper: Filming Amines — Use and Misuse in Power Plant Water-Steam Cycles (1955 American Power Conference), it is apparent that octadecylamine is stable up to pressures substantially in excess of 200 psig. In addition, Dearborn Chemical Co is treating a considerable number of 600 psig boilers with good condensate corrosion inhibition and with no indication of decomposition. The reason for successful operation at 600 psig is that octadecylamine is very stable under boiler conditions and octadecylamine steam distills so very rapidly that very little is in the boiler at any instant.
>
> Further, it is stated that: "A secondary benefit derived from the filming amines is their ability to promote dropwise condensation of the steam which could provide more efficient heat transfer than film condensation. However, the amine film usually has a low heat transfer coefficient. There is no published information available as to the magnitude of this amine film coefficient, which makes a cost estimate involving the heat transfer have little meaning." It is believed that this statement is misleading and incorrect.
>
> In a talk entitled: Filming Inhibitors for Corrosion Control and Increased Heat Transfer in Steam Condensing Systems, given before the National District Heating Association at Chicago in May 1955, Dr. M. F. Obrecht stated: "For film condensation of steam, a conservative film coefficient (h_c) of 1000 was used. In many cases measured values of (h_c) have been as low as 600. A steam side coefficient (h_s) of 10,000 was used for dropwise condensation. This also is a conservative value since dropwise coefficients as high as 70,000 have been reported. . . . In all cases, a zero fouling was assumed on the side being treated."
>
> A little thought will indicate that the film coefficient of the amine film will be very high. The amine film is essentially monomolecular and hence heat transfer approximates that of bare steel — a very high value.
>
> In addition, it is obvious that removal of fouling (corrosion products and associated scale deposits) resulting from use of filming amines will contribute to a greatly improved heat transfer coefficient. Field practice confirms the considerable overall heat transfer increase obtainable from use of filming amines. . . .

We elected to remain neutral (i.e., we ducked!) and sent Denman's letter to Scharp, who replied forthwith in this wise:

> While it is true that the filming amines boil at 600 plus degrees without major decomposition, they may and do break down to deposit hydrocarbon tars in boilers troubled in a minor degree by hot spots. Our Company is in possession of confidential data, taken from a power boiler, which substantiates this statement. . . .
>
> Deposits were proved by feeding filming amines to produce the deposit; feeding caustic soda to remove the deposit; and repeating the operation several times. High tube temperatures were produced during the amine feed and persisted after it stopped. Tube temperatures returned to normal and remained so when the deposits were removed by caustic soda; and high temperatures returned on resumption of amine feed.
>
> It is unusual that we hear of boilers operating below 600 psig that have experienced trouble with hot spots and possibly never do we hear of such trouble on boilers operating at and below 200 psig. . . .
>
> It is believed that the filming amines must be cautiously applied and diligently observed, if used. The higher ***continued on page 98***

About the Cost of Living . . . with Steam Traps

WHEN YOU specify steam traps, what could possibly be more important than *the cost of living with them* — production cost . . . steam cost . . . downtime cost . . . repair cost.

No steam traps manufactured have ever provided greater equipment operating efficiency or lower trap maintenance cost than Armstrongs.

Consider the experiences of these companies:

"30% Greater Output from platen presses since installing Armstrong Traps" — rubber processor.

"$8000 Annual Fuel Saving since replacing 600 traps with Armstrong" — metal processor.

"30% Less Downtime for repairs with Armstrong Traps" — food processor.

"$25,000 Trap Maintenance Saving every year since installing 4000 Armstrong Traps" — major chemical plant.

You may well ask, "Can there really be so big a difference in steam trap performance?" The answer is: These are typical experiences of people who have compared Armstrong trap performance — not for a month or a year, but over periods of 2, 5 and even 10 years or more.

The Armstrong trap has certain fundamental advantages, including:

No Steam Loss — the valve is always water-sealed.

Large air-venting capacity — air is automatically discharged along with condensate.

Long-life parts — hardened chrome steel valve and seat — all other parts corrosion-resistant stainless. Absolutely nothing to stick, bind, clog or collapse. Not affected by ordinary dirt and scale.

Unconditionally guaranteed to satisfy. It takes an awfully good product to carry such a guarantee.

Steam traps can have such a big effect on plant operating efficiency, they are worth more than casual consideration. Let your Armstrong Factory Representative answer your questions. There is no obligation. Call him or write:

ARMSTRONG MACHINE WORKS
8103 Maple Street • Three Rivers, Mich.

Do you have "The Steam Trap Book"? — 44 pages of useful data on trap sizing, calculation of condensate loads, installation and maintenance. Free on request.

ARMSTRONG STEAM TRAPS

For more data circle 504 on Post Card

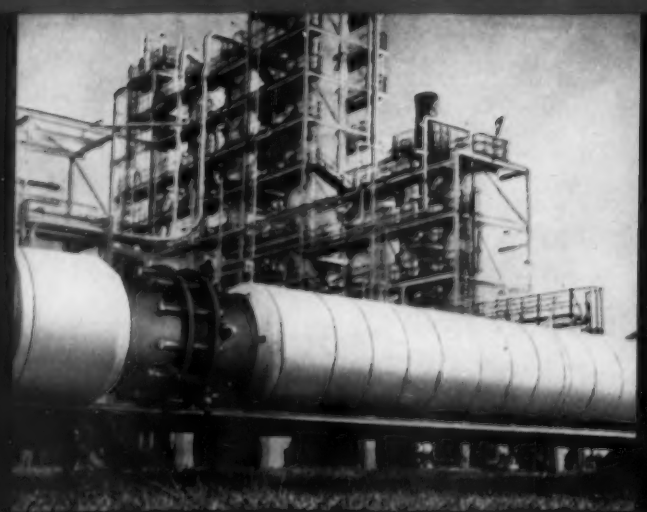
why engineers

IN THE AIR...

These Gun-Pakt Joints in overhead line are some of 22 Yarway Gun-Pakt Joints installed at a large Southern hospital.

ON THE GROUND...

One of 37 Yarway Gun-Pakt Expansion Joints installed at giant oil refinery. Gun-Pakt Joints at this refinery range in size from 1½" to 14".



UNDERGROUND...

Yarway Gun-Pakt Joints installed in manhole of new steam distribution line of large Eastern utility. 12 Gun-Pakt Joints 12" and 18" are installed in this line; scores of other Gun-Pakts up to 24" are used by this utility.

YARWAY

go for Gun-Pakt Expansion Joints

■ Engineers go for Yarway Gun-Pakt Expansion Joints because:

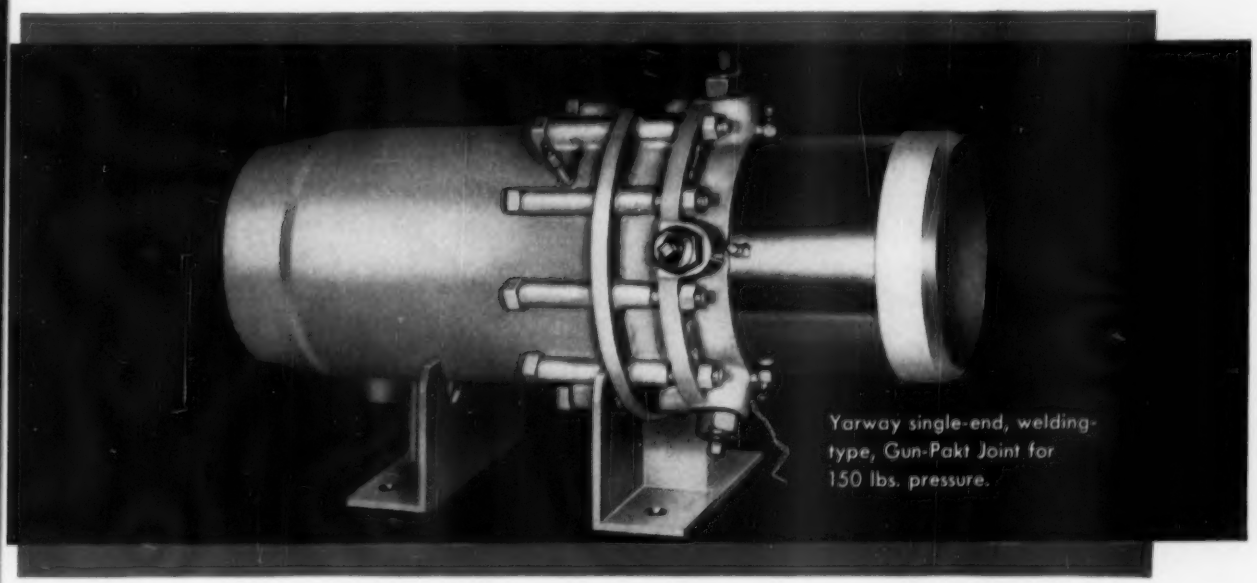
NO SHUTDOWNS. With Gun-Pakt Joints when new packing is needed, it is added under full steam pressure, right on the job—no unpacking, no shutdowns, no service interruptions.

FEWER JOINTS NEEDED. With Gun-Pakt Joints you need fewer joints per length of pipe line, with traverses up to 12″ single and 24″ double.

LONG SERVICE—NO METAL FATIGUE. Gun-Pakt Joints give long, trouble-free service life—no fatigue failures.

LOW MAINTENANCE. Maintenance records show the costs for servicing Gun-Pakt Joints are very low. One utility reports only 65 cents per year per joint—another reports less than half that.

Leading institutions, central heating stations and industrial plants "go for Gun-Pakt" again and again. Write now for latest bulletin EJ-1914.



Yarway single-end, welding-type, Gun-Pakt Joint for 150 lbs. pressure.

A few typical users of Yarway Gun-Pakt Expansion Joints

UTILITIES	INSTITUTIONS	INDUSTRIAL PLANTS
Detroit Edison Company	Central Heating Plant, Washington, D.C.	Ford Motor Co. of Canada
Georgia Power Company	Delaware County (Pa.) Prison	General Motors Corp. (Buick Division)
Ohio Edison Company	N.Y. Hospital & Cornell Medical Association	General Motors Corp. (Oldsmobile Division)
Rochester (N.Y.) Gas & Electric Co.	Purdue University	Westinghouse Electric Corp.
Pacific Gas & Electric Co.		
Philadelphia Electric Co.		

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Penna.
BRANCH OFFICES IN PRINCIPAL CITIES

GUN-PAKT EXPANSION JOINTS

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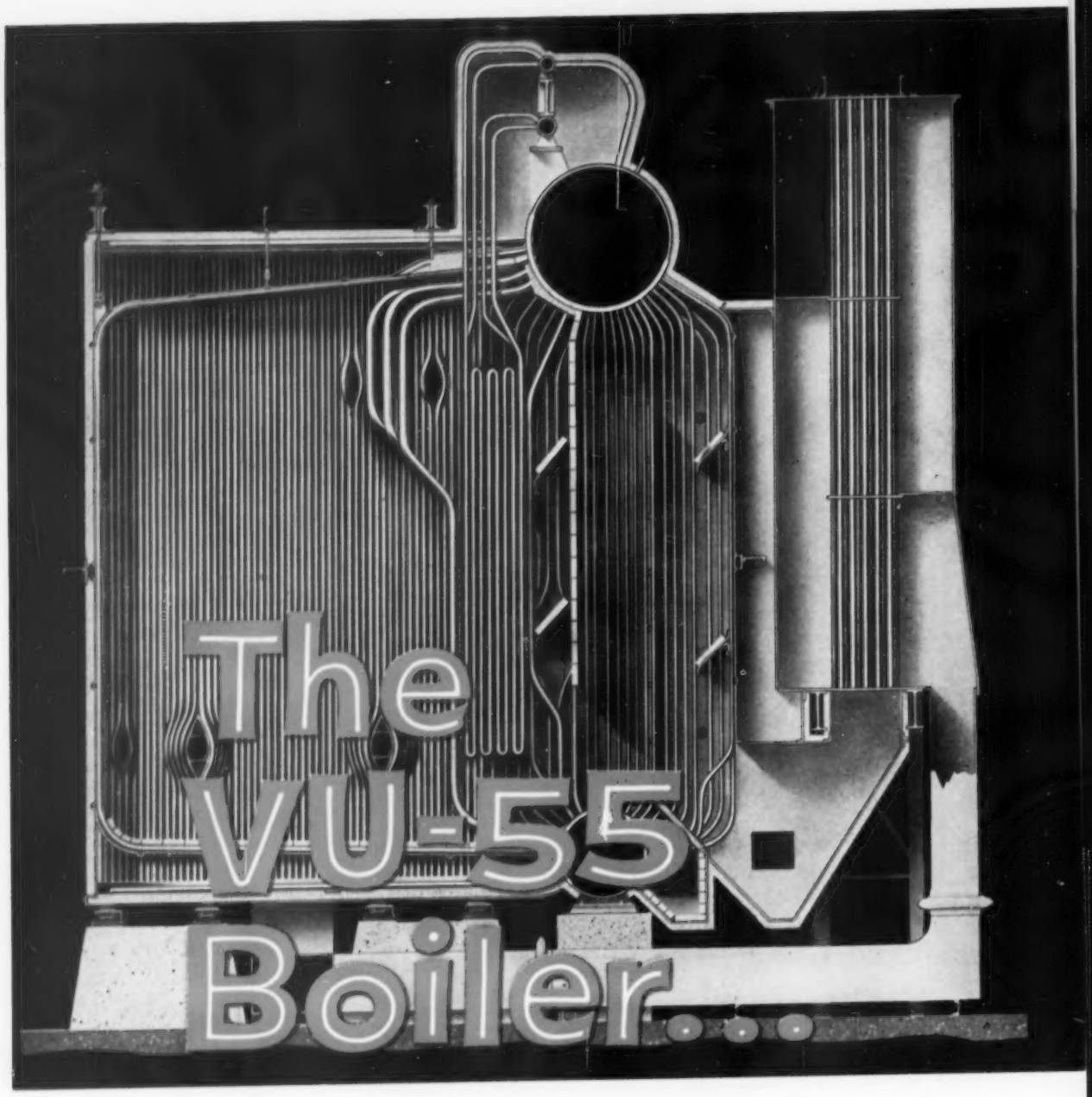
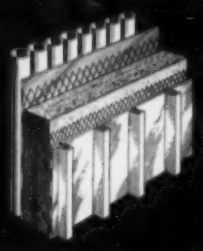


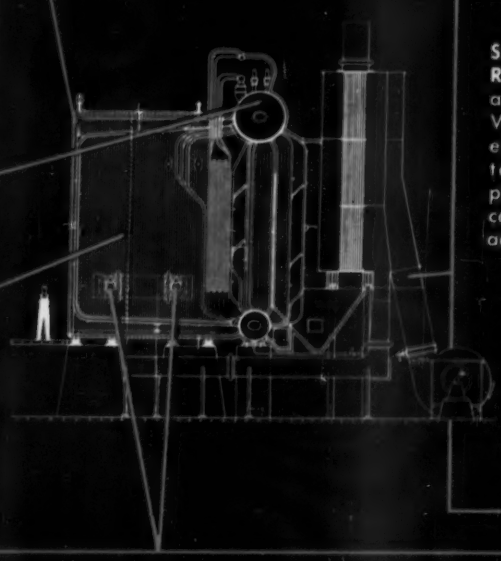
Custom Features, Standard Sizes, Advanced Design



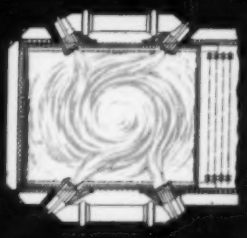
DOUBLE WALL, PRESSURE-TIGHT CASING. The latest development in casing construction for pressure firing of boilers in the size class of the VU-55, this casing is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs. Construction consists of tangent tubes backed up successively by welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and assure ample strength. Low heat loss and the tightness required for pressure firing are assured by this double-wall construction.

HIGH STEAM QUALITY. Equipped with a large (60-in.) steam drum, the VU-55 has generous water capacity and steam reservoir space. C-E drum internals assure high quality steam at all ratings.

TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated, heat absorption rates per sq. ft. are higher.



STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and the ducts from air heater to burners are beneath the furnace floor.



TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing. About 90 percent of Combustion's large utility installations use this advanced method of firing. Flame streams from the four burners impinge upon one another at high velocity, as shown, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.

The VU-55, newest of the C-E line of Vertical Unit Boilers, represents the closest approach to central station performance yet achieved in standardized boilers in its capacity range.

Its design combines a number of time-tested and service-proved features, such as Tangential Burners, double wall, pressure-tight casing, and tangent furnace tubes. In addition, this bottom-supported unit requires no outside supporting steel, is economical of space and streamlined in appearance.

It is available in 5 sizes for capacities from 50,000 to 120,000 lb per hour. It is designed for 3 pressure ranges (250, 500 and 750 psi) and can be equipped with a superheater to provide temperatures up to 750 F. Either a tubular or a regenerative air heater is available.

The VU-55 Boiler is symmetrical in design, performs efficiently over a wide range of output, and is easy to operate and maintain.

It is, in fact, the boiler with the custom features and the advanced design.

COMBUSTION ENGINEERING

B-978

Combustion Engineering Building

200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd.

all types of steam generating, fuel burning and related equipment; nuclear reactors; paper mill equipment; pulverizers; flash drying systems; pressure vessels; soil pipe.

For more data circle 506 on Post Card

Station Load changes from 100% to 12%

...ON AUTOMATIC CONTROL

Hagan Automatic Systems help keep Niagara Mohawk Albany Station on frequency control

A new station seldom encounters as drastic load changes as Niagara Mohawk's Albany Station. At the end of a chain of water power stations, it has the job of taking up the slack as water level and power demand varies. During the spring season, it may swing from 50 MW at night to its maximum rated output of 400 MW during the day. No matter how low the load falls, the station stays on automatic.

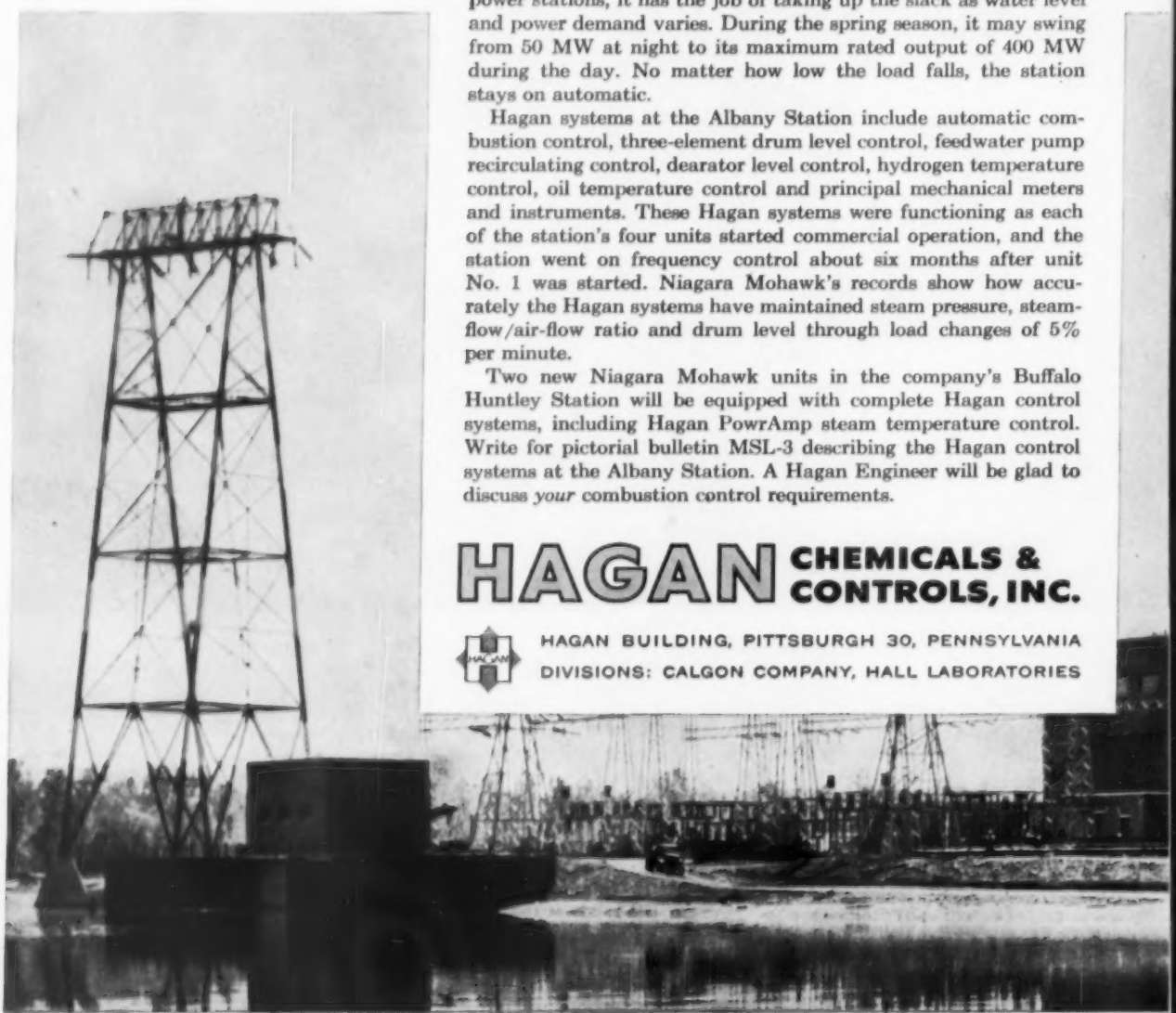
Hagan systems at the Albany Station include automatic combustion control, three-element drum level control, feedwater pump recirculating control, dearator level control, hydrogen temperature control, oil temperature control and principal mechanical meters and instruments. These Hagan systems were functioning as each of the station's four units started commercial operation, and the station went on frequency control about six months after unit No. 1 was started. Niagara Mohawk's records show how accurately the Hagan systems have maintained steam pressure, steam-flow/air-flow ratio and drum level through load changes of 5% per minute.

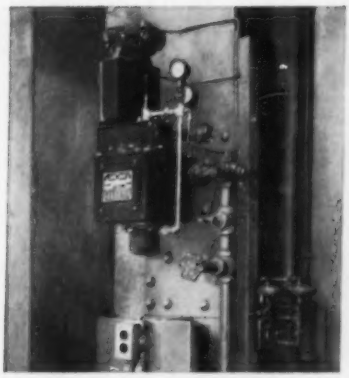
Two new Niagara Mohawk units in the company's Buffalo Huntley Station will be equipped with complete Hagan control systems, including Hagan PowrAmp steam temperature control. Write for pictorial bulletin MSL-3 describing the Hagan control systems at the Albany Station. A Hagan Engineer will be glad to discuss *your* combustion control requirements.

HAGAN CHEMICALS & CONTROLS, INC.

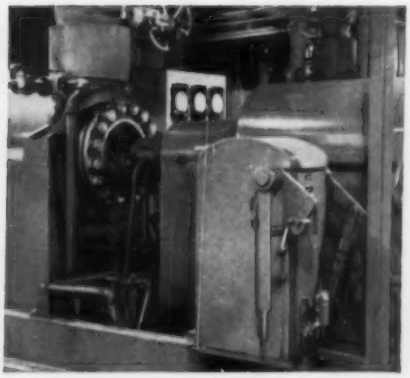
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA

DIVISIONS: CALGON COMPANY, HALL LABORATORIES

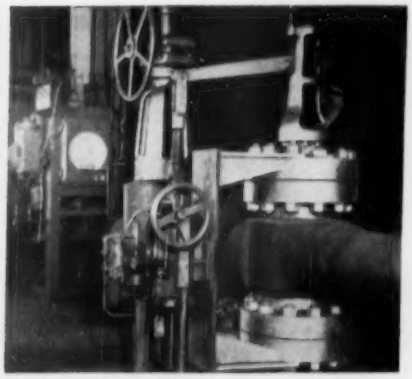




Hagan Furnace Pressure Regulator. This installation is equipped with the Hagan remote switching system, eliminating the lag normally present in long-line pneumatic systems. Controlling the Forced Draft Fan inlets, this Hagan Regulator is a unique instrument. Instant response, high stability and wide range adjustment makes the Hagan Regulator easy to tailor to a specific application.



Boiler Feed Pump Hydraulic Coupling Control. Here a 6 x 10 Hagan Power Positioner implements the signal from the feed water control. This Power Positioner is one of a full range of sizes suitable for many positioning applications. Hagan Power Positioners are fast and accurate, with dependable repeatability. The panel in the background contains Hagan Ring Balance meters which record the three separate flows, totalize each flow and record the total of all three.



This 5 x 10 Hagan Power Positioner positions the feedwater control valve. Normally on standby, this valve is an alternate means of feedwater control. The Hagan Ring Balance Meter in the background transmits boiler drum water level, compensated for changes in density. This provides reliable and accurate drum level reading from atmospheric pressure to full operating pressure when going on or off the line. For details on this unique system, ask for Bulletin MSA-117.

For more data circle 507 on Post Card

Here's what makes Bronze Valves

TYPICAL OF WALWORTH QUALITY is the union body-to-bonnet connection which stiffens the body against internal pressure; makes taking the valve apart a simple operation and reduces the chances of distortion or leakage even though the valve is repeatedly taken apart and reassembled. With this type of construction there is no possibility of the bonnet coming off the valve while the handwheel is being turned.

HEAVY BODY CONSTRUCTION is typical of *all* Walworth Bronze Valves. Extra-thick walls and rugged wrench hexes constitute a high safety factor and prevent distortion while the valve is being installed in the pipeline. Extra-deep pipe threads are accurately machined to eliminate leakage. Walworth Bronze Valves are also available with flanged, silver-brazed or soldered ends in certain sizes and types.

MEET THE CHAMP! The chief engineer of a midwestern plant had used a parade of valves in severe boiler blowdown service. Most didn't last longer than 60 days. None survived 90 days.

On the recommendation of a Walworth Representative the engineer installed the Walworth No. 225P Bronze Globe Valve shown here, stating that he would be entirely satisfied if it lasted a bare three months. Exactly 4 years and 362 days later the valve was taken out of service—not due to the wire drawing, steam cutting and galling which made the other valves short-lived—but because the highly turbulent steam finally wore a small hole in the body.

This is the kind of valve satisfaction you get—when you specify and use Walworth Bronze Valves. They are the longest wearing, toughest bronze valves on the market.

Walworth Subsidiaries: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO.

Walworth *the* real bargain!

EXTRA-LARGE STEMS with extra-long, extra-deep threads prolong valve life, protect against wear and distortion and provide tight positive shutoff. The surface of the stem is machined to a glass-like finish for minimum handwheel effort and to preserve the packing which results in fewer inspections and less maintenance. The top of the stem is tapered and squared to hold the handwheel securely.

TO REDUCE WIRE DRAWING to a minimum, certain types of bronze globe valves have stainless-steel plug-type seats and discs heat-treated to a nominal hardness of 500 Brinell, adding years to valve life even in severe services. These valves can be tightly closed on sand, grit or pipe scale without damage. Seats and discs are machined simultaneously, assuring perfect mating.

There is a Walworth Bronze Gate, Globe, Angle or Check Valve for every service. Walworth is continually developing new valve types and materials, including plastics, to keep pace with the growing variety and severity of services in modern industry. For full information, see your Walworth Distributor or write: *Walworth, 60 East 42nd Street, New York 17, N. Y.*

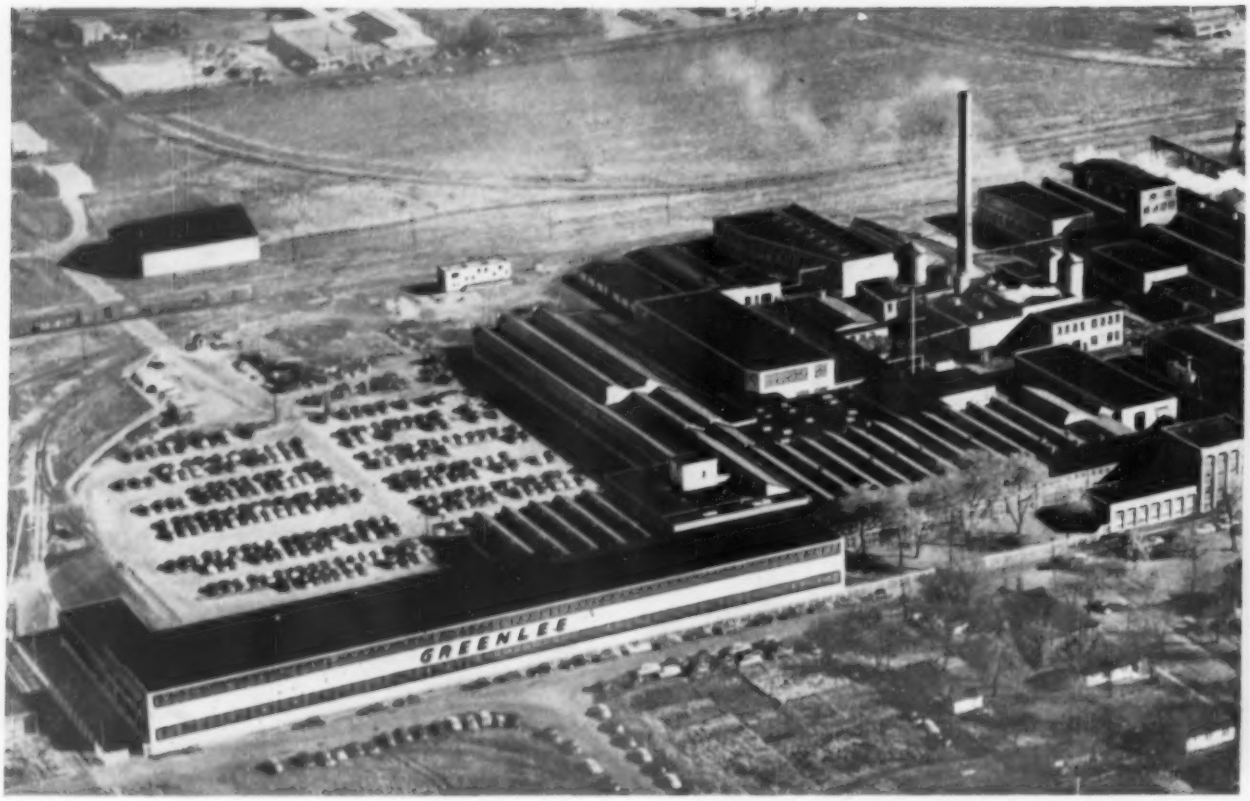
WALWORTH

Bronze Valves and Fittings

M & H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING AND WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.

For more data circle 508 on Post Card

GREENLEE BROS. & CO.



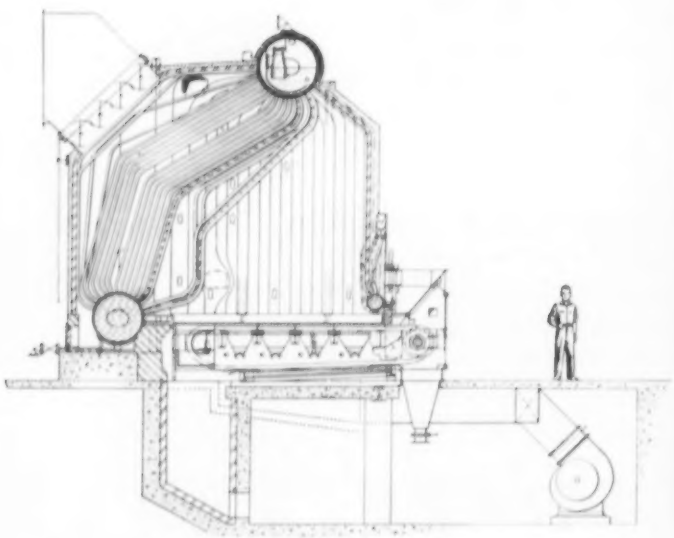
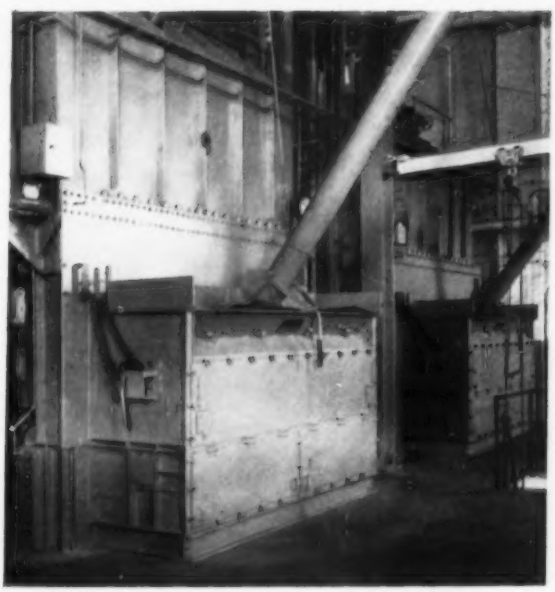


Diagram of B&W Integral-Furnace Boiler with Jet Ignition Stoker. Each unit generates 30,000 lbs of saturated steam per hour at 125 psig.



Two B&W Integral-Furnace Boilers at Greenlee, equipped with B&W Jet Ignition Stokers, burn a wide variety of Illinois bituminous coal.

CUT FUEL COSTS 14%

B&W Boilers with Jet Ignition Stokers assure savings despite increased fuel prices

As one of the country's leading manufacturers of machine tools, Greenlee Bros. & Co., Rockford, Illinois uses large amounts of steam for all year operation of air compressors and for plant heating. And to maintain profitable overall operation it is important that the steam supply be dependable—and steam generating costs kept to the minimum.

Since the installation of two B&W Integral-Furnace Boilers, Greenlee has enjoyed uninterrupted steam service from a dependable, efficient source. Equipped with modern B&W Jet Ignition Stokers, the B&W units have established an outstanding record of operating efficiency while burning a wide variety of Illinois bituminous coal.

At Greenlee, as at other industrial plants using steam, careful consideration of long term costs and proven reliability were important factors in the choice of B&W Integral-Furnace Boiler units.

If your steam production cost is important . . . if you are considering steam plant modernization or expansion for increased dependability and efficiency . . . it will pay you to investigate B&W's more than 90 years of boiler experience. Let us show you what it can do for you. For further information or assistance write to The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-773-B

HERE'S WHY YOUR STEAM COSTS LESS With B&W Integral-Furnace Units

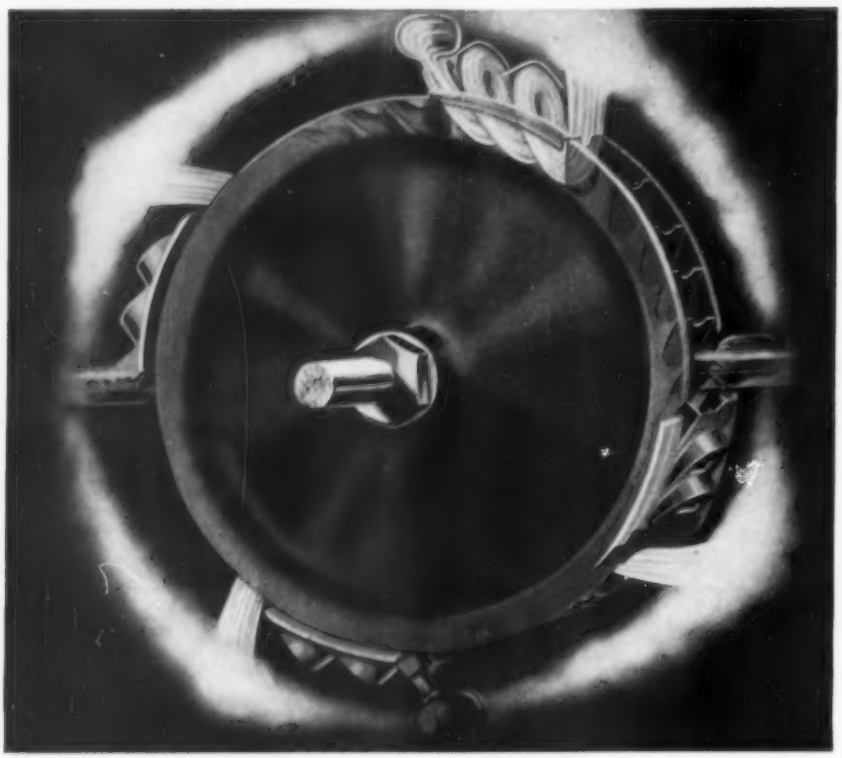
- Minimum floor space and headroom requirements
- High fuel economy
- Smokeless combustion
- Adaptable to all fuels and firing methods
- Economical fast steaming
- Water-cooled furnace
- Clean, dry steam at all ratings, even with high boiler water concentration
- Quick response to wide and heavy load swing demands
- Easy to inspect and clean
- High availability with least attention

BABCOCK & WILCOX

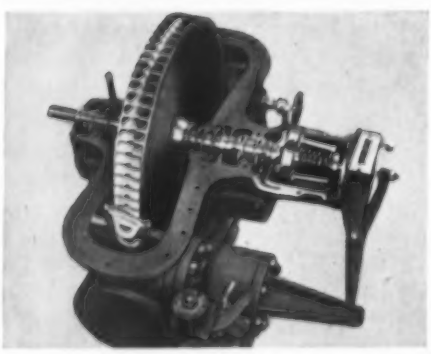
BOILER DIVISION

For more data circle 509 on Post Card

TURBINE BLADES CAN'T FOUL!



The Terry solid-wheel turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.



Terry solid-wheel design permits large clearances

In the Terry solid-wheel turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.

The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many advantages of Terry solid-wheel turbines. Write for complete details. Ask for a copy of bulletin S-116.

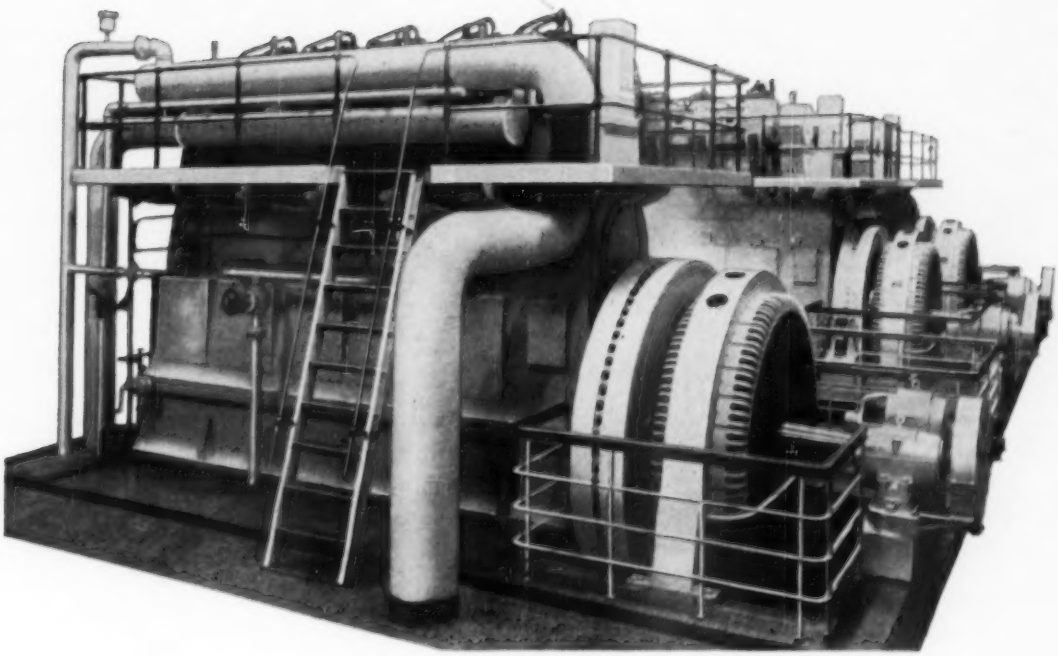
THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1206

For more data circle 510 on Post Card

STOP Carbon Sludge Varnish



There's good reason why Sinclair RUBILENE® Oil has a great record in industrial Diesel applications. RUBILENE prevents the formation of carbon, sludge and varnish in Diesels. It stands up under highest operating temperatures, provides better lubrication protection to cylinders, pistons, rings and other vital moving parts. It cuts oil consumption, reduces service time to a minimum.

Now's the time to switch to Sinclair RUBILENE. Whatever the make or age of your Diesel, whatever your lubrication problem, there's a RUBILENE or RUBILENE HD Oil that precisely meets your requirements. Call your Sinclair Representative for further information or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

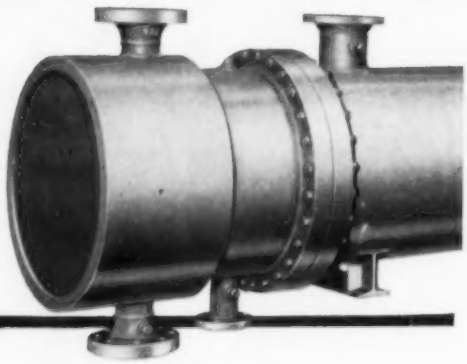
SINCLAIR RUBILENE OILS

For more data circle 511 on Post Card

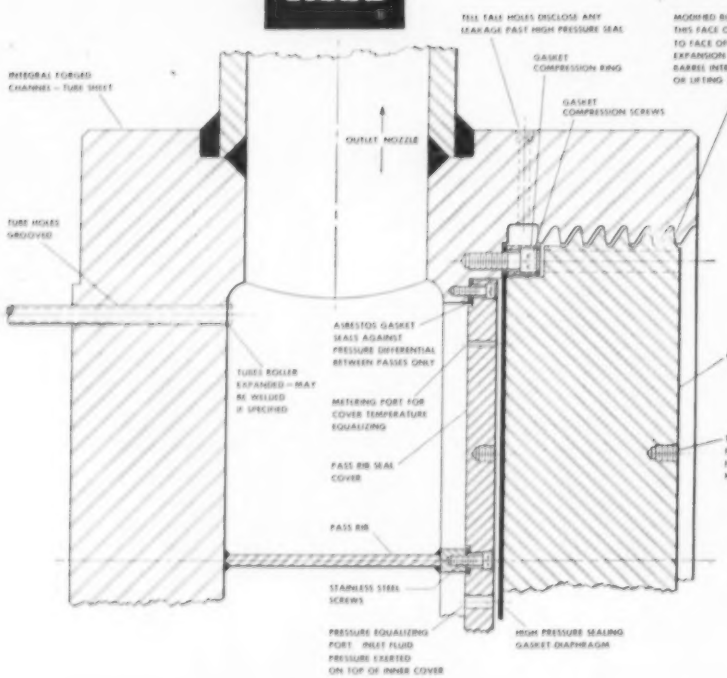
INSIDE FACTS

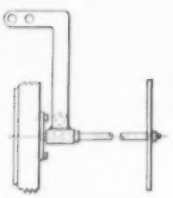
on the simplicity, safety and operating advantages of the exclusive Ross High Pressure Closure Design*

- Simpler design.
- Fewer parts to handle.
- High pressure seal unaffected by hydrostatic loads.
- Greater safety factor.
- Sudden load fluctuations no problem.
- Outer cover cannot corrode and bind . . . easily removed.
- Easily opened for inspection.

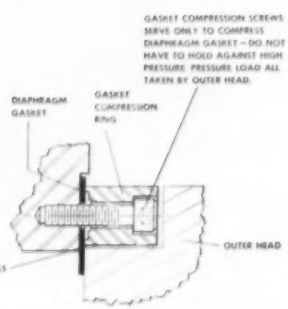


ROSS


TELL TALE HOLES DISCLOSE ANY LEAKAGE PAST HIGH PRESSURE SEAL
GASKET COMPRESSION RING
MODIFIED BUTTRESS THREAD. THIS FACE OF THREAD PARALLEL TO FACE OF HEAD. DIFFERENTIAL EXPANSION BETWEEN HEAD AND BARREL INTRODUCES NO WEDGING OR LIFTING ACTION IN HEAD.
INTEGRAL FORGED CHANNEL – TUBE SHEET
GASKET COMPRESSION SCREWS
OUTLET NOZZLE
TUBE HOLES GROOVED
ASBESTOS GASKET SEALS AGAINST PRESSURE DIFFERENTIAL BETWEEN PASSES ONLY
OUTER COVER
TUBES ROLLER EXPANDED – MAY BE WELDED IF SPECIFIED
METERING PORT FOR COVER TEMPERATURE EQUALIZING
TAPPED HOLES IN INNER AND OUTER HEADS FOR ATTACHING HANDLING BRACKET
PASS RIB SEAL COVER
PASS RIB
STAINLESS STEEL SCREWS
PRESSURE EQUALIZING PORT. INLET FLUID PRESSURE EXERTED ON TOP OF INNER COVER
HIGH PRESSURE SEALING GASKET DIAPHRAGM



TYPICAL COVER HANDLING BRACKET FOR HORIZONTAL UNIT


GASKET COMPRESSION SCREWS SERVE ONLY TO COMPRESS DIAPHRAGM GASKET – DO NOT HAVE TO HOLD AGAINST HIGH PRESSURE. PRESSURE LOAD ALL TAKEN BY OUTER HEAD.
DIAPHRAGM GASKET
GASKET COMPRESSION RING
OUTER HEAD
OUTER HEAD FURTHER SEALS DIAPHRAGM GASKET AGAINST SHOULDER OF CHANNEL BARREL

DETAIL OF GASKET COMPRESSION RING FACING

NOW FOR ALL THE DETAILS, request new Bulletin 5.6K1, mailed immediately. Write Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

ROSS HEAT EXCHANGER

Division of AMERICAN-Standard

*for feedwater heaters and other high pressure, high temperature exchangers

For more data circle 512 on Post Card

New Sarco Thermodynamic Steam Trap practically eliminates maintenance!

Only moving part—a hardened Solid Stainless Steel Disc—practically wear-proof!

SOME OF MANY ADVANTAGES

1. Same trap for all loads and pressures 10-600 psi.

2. Closes tight on no load.

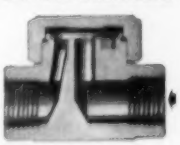
3. Operates against back pressures up to 50% of inlet pressure.

4. Not affected by superheat, water-hammer, vibration, corrosive condensate.

5. Smallest inventory of spare parts.

SIMPLICITY—to the Nth degree!

No valve-closing mechanisms to wear or stick. No critical clearances to choke. No gaskets to leak. Three simple parts...machined from stainless steel bar stock. Only one moving part.
What could be simpler?



SARCO COMPANY, INC.

2132-B

Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

Please send me: ☐ Bulletin 255-44
☐ A Sarco Thermodynamic Steam Trap for 60-day trial. Size____ for installation on _____

NAME _____

FIRM _____

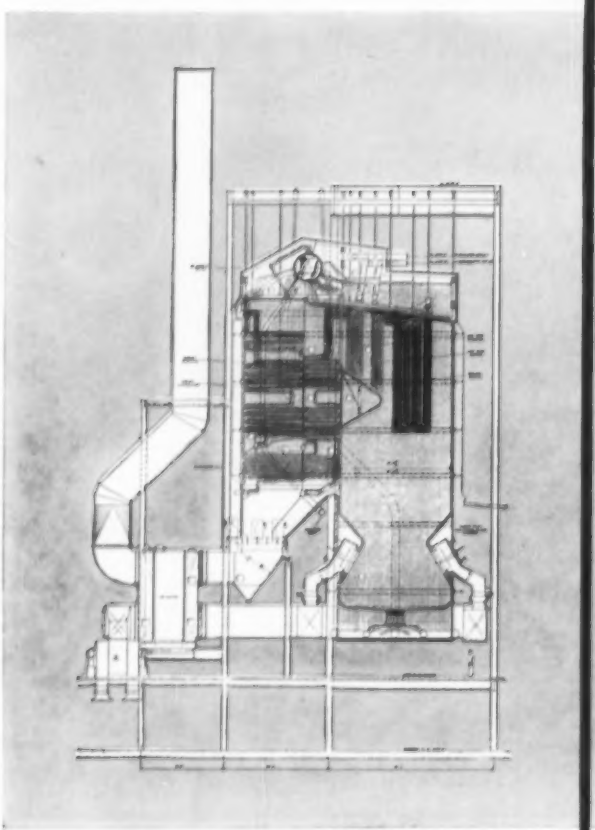
ADDRESS _____

CITY _____ STATE _____

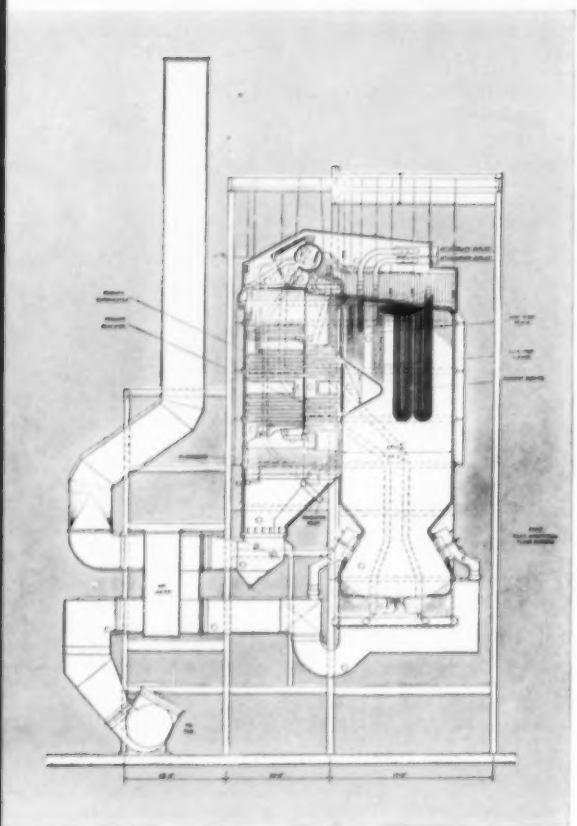
For more data circle 513 on Post Card

why southern and southwestern

RILEY TURBO



Riley Reheat TURBO FURNACE Unit:
For Texas Public Utility
Capacity: 825,000 lbs/hr. Pressure: 1750 psig design
Superheat and reheat temperatures: 1005 F
Fuels: Natural Gas, Oil, Future Coal
12 Riley Directional Flame Burners
Pressurized Turbo Furnace



Riley Reheat TURBO FURNACE Unit:
For Texas Public Utility
Capacity: 1,250,000 lbs/hr. Pressure: 2125 psig
Superheat and reheat temperatures: 1005 F
Fuels: Natural Gas, Oil and Future Lignite
16 Riley Directional Flame Burners
Pressurized Turbo Furnace

OTHER RILEY TURBO FURNACE UNITS INSTALLED OR ON ORDER

Northeast Paper Mill
One 175,000# Unit
Pulverized Coal

West Va. Chemicals Co.
One 289,000# Unit
Pulverized Coal

Eastern Seaboard
Public Utility
Three 500,000# Units
Fluid Coke

Southern Aluminum Co.
Two 320,000# Units
Gas, Oil, Future Coal

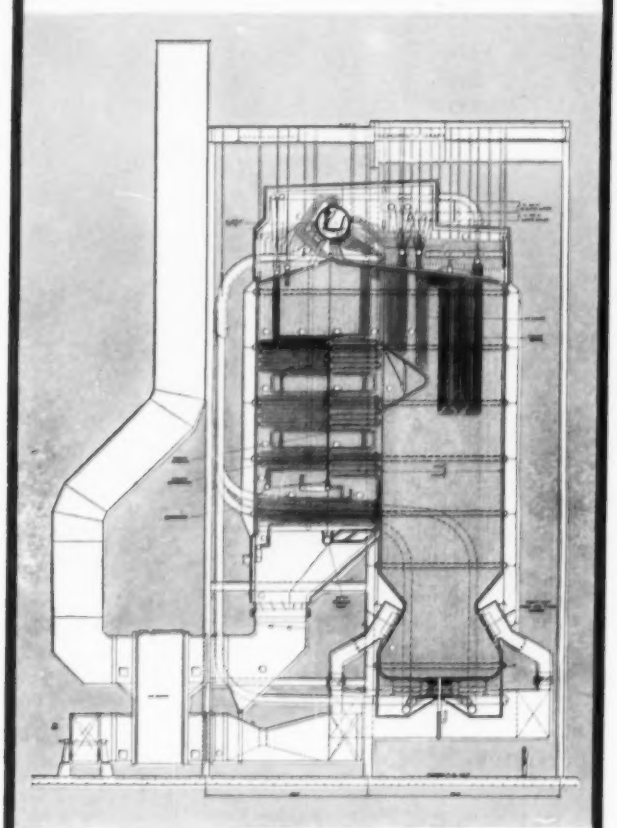
West Va. Chemicals Co.
One 175,000# Unit
Pulverized Coal

Phillipine Islands
Public Utility
One 430,000# Unit
Oil

RILEY DESIGNS, MANUFACTURES AND INSTALLS COMPLETE STEAM GENERATING UNITS AND FUEL BURNING EQUIPMENT FOR PUBLIC UTILITY AND INDUSTRIAL POWER AND HEATING PLANTS

public utilities are installing

FURNACE UNITS



Riley Reheat TURBO FURNACE Unit:
Louisiana Public Utility
Capacity: 1,550,000 lbs/hr. Pressure: 2125 psig design
Superheat and reheat temperatures: 1005 F
Fuels: Natural Gas, Future Oil, Pulverized Coal,
Lignite, Delayed Coke, Fluid Coke.
20 Riley Directional Flame Burners
Pressurized Turbo Furnace

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

BECAUSE . . . the TURBO FURNACE makes possible change-over from natural gas and oil to solid fuels firing with minimum of outage and minimum conversion cost . . . at the same time it provides a superior, efficient means of firing gas or oil.

When conversion to solid fuels becomes economically advisable the only major expense is the addition of pulverizers. Riley Directional Flame Burners are already equipped with coal heads for easy, quick hook-up to pulverizers.

USES A WIDE RANGE OF FUELS

The method of firing and the high heat and high turbulence in the combustion zone makes possible the efficient and economical use of any fuel that is burned in suspension: gas, oil, all grades of coal, lignite, delayed cokes and fluid coke.

OFFERS MANY ADDED ECONOMIES

- Flyash disposal is eliminated by reinjecting flyash and converting it to slag.
- Minimum carbon loss, higher efficiency.
- Clean furnace — no soot or slag blowing is needed; a large percentage of ash is retained in combustion zone and furnace exit gas temperatures are exceptionally low.
- More uniformity of furnace temperature across superheater and reheater.
- Method of firing makes possible less overall height.
- One level burner operation.

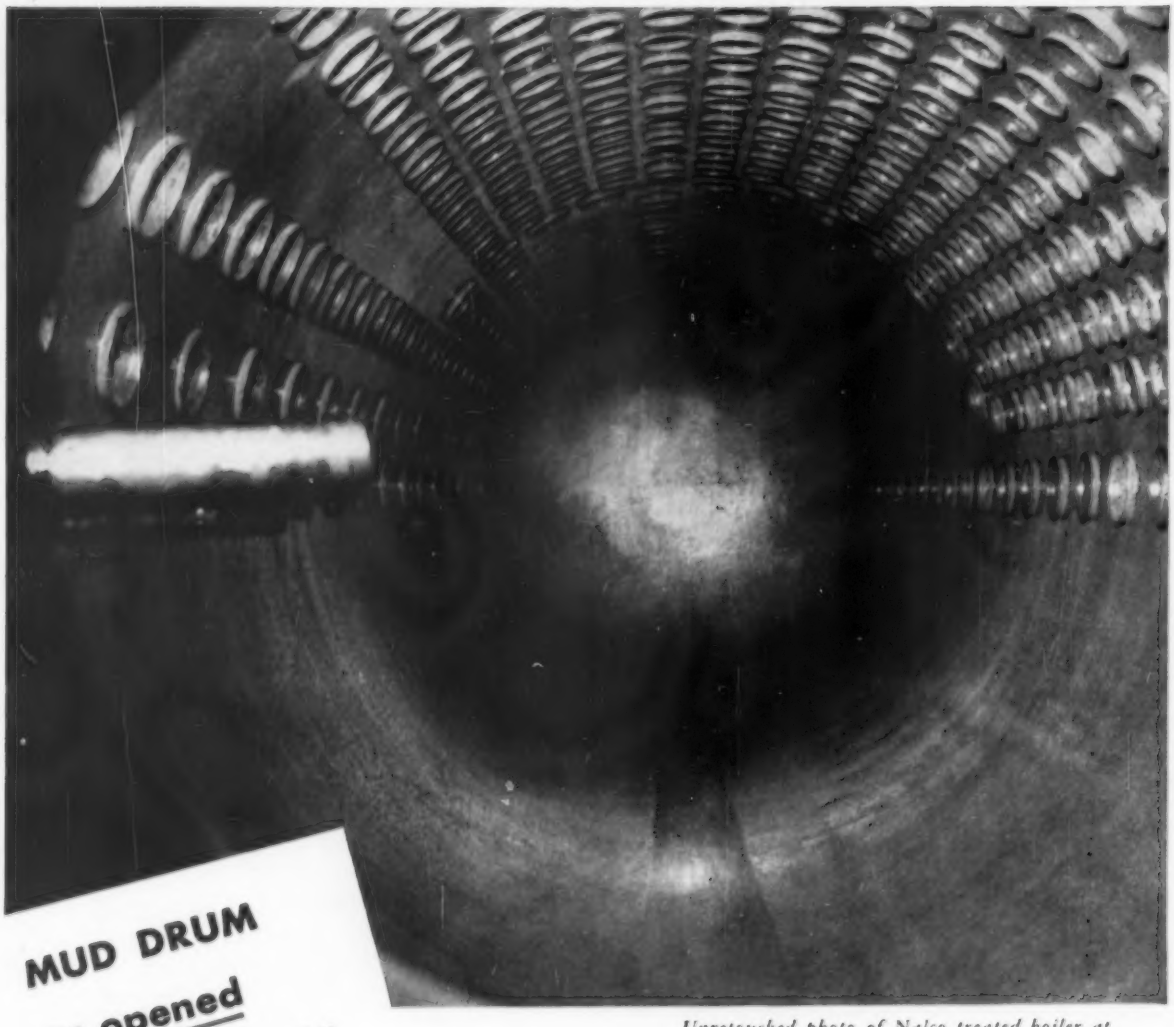
REMOTE AND ELECTRONICALLY CONTROLLED FIRING

Complete automatic and remote firing controls with electronic safeguards are available for Riley Directional Flame Burners.

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver (Englewood), Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

For more data circle 514 on Post Card



MUD DRUM
as opened
after one year
on line
with
THE *Nalco* SYSTEM

Unretouched photo of Nalco treated boiler at Georgia Institute of Technology, Atlanta, Georgia

● Calling this a mud drum serves only to identify its location . . . it is perfectly clean after a full year on line. The unretouched photo was taken immediately after the drum was opened. No wash-out was necessary. Not only is the drum free of scale and corrosion . . . Nalco sludge conditioning operated so effectively that even under the static, off-line draining condition, no sludge deposited in tubes or drums.

The Nalco System can get results like these, economically, in *your* plant—regardless of boiler size or pressure. Write or phone Nalco today for action on a complete water treatment program.

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HELPFUL BULLETINS

INSTRUMENTS AND CONTROLS

101 Liquid and Gas Control — General Catalog 005, 38 pp, describes company's line of equipment for the measurement and control of liquids and gases. Illustrated are many types of controllers, gages, manometers, recorders, meters, valves, Venturi tubes, etc., all applicable for water and sewage works, power and processing industries. Photos, drawings, head loss curves, specifications and dimensional data are included. Simplex Valve and Meter Co.

102 Panel Instruments — Bulletin 2057, 6 pp, contains descriptions and specifications of company's line of stock panel instruments. Illustrated with photos of meter styles and various movements available, it also contains dimensional drawings for meter mounting. Typical meter scales are reproduced in actual size. Simpson Electric Co.

103 Pneumatic Transmission System — Bulletin 750, 8 pp, describes the Laminair, a form of pneumatic transmission developed to provide a sensitive and accurate type of instrumentation. Advantages are listed and cutaway view showing component parts is included. Suggested specifications are also given. Simplex Valve and Meter Co.

104 Rotating Vacuum Transmitter — Catalog 70-27 describes a rotating vacuum transmitter for automatic chlorine proportioning. Application and operation are detailed and drawings of component features included. Fischer & Porter Co.

105 Thermostatic Controls — This 8-pp bulletin describes design, construction and operation of tubular type Temp-Guard thermostats that make or break an electrical circuit by responding to changes in temperature or electrical load. They are used to protect electric motors against overheating and overloading; turning electrical current on and off in cycling systems; activating alarm systems. Booklet is illustrated with cross-section drawings, photos of models, and charts of sizes, capacities. The Franklin Dales Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 105 and 106.

106 Chlorine Gas Feeders — Simplicity of operation of company's chlorine gas feeders is described in Bulletin 840-N10, covering the visible flow indicator, visible vacuum pyrex bell jar and positive-control chlorine diaphragm valve. Four types of control are diagrammed, and construction features, operation and application advantages, safety features, dimensions and control variations are discussed. Builders-Providence, Inc.

107 Continuous Feeding — The many distinct advantages which simplified design and construction can bring to the continuous volumetric feeding of liquids and slurries are described in Bulletin 65-H12B. Illustrations, a line drawing of a typical process installation, and dimensional drawings are included. Omega Machine Co.

108 Thermal Conductivity Analyzers — Bulletin TD-507, 16 pp, contains information on practical application and operation of thermal conductivity analyzers. Complete with photos, drawings, and diagrams, it offers valuable information on continuous gas analysis instruments. Thermal conductivities of gases are tabulated and a typical calibration curve for air-H_2 mixture is included. Arnold O. Beckman, Inc.

109 Combustion Instrument — Product Specification E65-5 describes the Heat Prover combustion analyzer which indicates, by volume, oxygen and combustibles present in the exhaust gases from boiler and industrial furnaces. Operating and physical characteristics are provided, together with a list of accessories and ordering information. Bailey Meter Co.

110 Remote Positioning Controls — Bulletin J-100, 8 pp, covers electrical remote positioning controls for both push button and automatic operation. Design and construction features are detailed, and photos, diagrams, and specifications included. The Jordan Co., Inc.

MECHANICAL POWER TRANSMISSION

111 Variable Pitch Drives — Catalog V-183-A, 12 pp, features a line of wide range variable pitch sheaves, companion sheaves, and belts. Cutaway views showing component features are included, as well as dimensional diagrams, specifications, engineering information and tables of practical stock drive combinations. Browning Mfg. Co.

112 Magnet Brake — Bulletin GEA-6214, 8 pp, describes outstanding features of a d-c magnet brake, explains simplified installation and maintenance procedures, provides cutaway drawing that pinpoints brake's operating features. It also describes wide variety of applications, and provides diagrams and tables that show how the brake meets AISE standards in 8, 10, 13, 16, 19, and 23-in. wheel sizes. General Electric Co.

113 Flexible Couplings — Eight-pp Bulletin CPI-56 contains complete descriptive information on flexible couplings, together with engineering data, horsepower ratings, parts lists and prices. Photos and dimensional diagrams are included, and the data are presented in tabular form. Acme Chain Corp.

114 Precision Stock Gears — Many new items have been added to 88-pp Catalog E-88 on precision stock gears, including the miniature slip clutch. Complete engineering information is presented in tabulated form on the various types of precision stock gears, and dimensional diagrams showing important features are included. Additional information is offered on a fly-leaf. Dynamic Gear Co., Inc.

VALVES, PIPING, FITTINGS

115 For Valve Selection — Circular 555, 22 pp, is designed as a guide for selecting valves, boiler mountings, and lubricating devices, including company's LQ600 bronze globe valves, Luncor PVC all-molded valves, and solder end valves. Tables, technical data and information on the selection of valves, boiler mountings, and lubricating devices are completely indexed for easy reference. The Lunkenheimer Co.

116 Condensed Data on Valves — Bronze valves for heating and plumbing applications are pictured and described in Condensed Catalog 146. Special emphasis is given to heavy duty globe, gate and check valves. Also covered are radiator and circulator valves and fittings for steam, gravity and forced hot water heating systems, and company's standard line of globe, gate and check valves. Hammond Brass Works.

117 Plastic Pipe, Fittings — Catalog P101 is an 8-pp engineering booklet providing technical and descriptive data on plastic pipe, fittings and valves. Prepared with process industry installations in mind, this catalog includes comprehensive tables detailing both physical properties and chemical resistance of the three basic plastic compounds used: PVC, Styrene-Copolymer and Buna-N. Also lists sizes of fittings, dimensions and working pressures of pipe, and sizes and types of valves. Vanton Pump & Equipment Corp.

118 Steel Tubing, Fittings — Bulletin V-157 describes steel tubing and fittings for vacuum systems and conveying lines. Specifications are included, as well as data on performance, capacity, and installation methods. Photos of typical installations and numerous diagrams showing details of construction and design are furnished. H-P Products, Inc.

119 Adapter Fittings — Twelve-pp Catalog 4360 shows straight thread plugs and adapters, O-rings for straight thread fittings, and steel and brass pipe fittings. Specifications are tabulated, and photos and drawings showing component features included. Tube & Hose Fittings Div., The Parker Appliance Co.

120 Steel Tube Fittings — Form 6071, a 48-pp catalog, incorporates complete engineering data on company's 7000 and 8000 Series Ermeto hydraulic flareless tube fittings and Flare-Twin SAE 37-deg flare (JIC) hydraulic tube fittings. In addition to full engineering specifications, a section is devoted to assembly instructions, materials, finishes and operating pressures. The Weatherhead Co.

FANS, VENTILATORS

122 Centrifugal Fans — Sixty-pp Bulletin C-103 lists manufacturer's latest line of backward curved blade centrifugal fans and features performance charts. These fans are designed for a wide range of ventilating, air conditioning and heating applications, and suitable for belt or direct drive. Specifications, special features avail-

able, are covered, and selection information is included. The Type B fan wheel is described as non-overloading and self-cleaning. Chicago Blower Corp.

123 Induced Draft Bifurcator — Bulletin DB-44-56 contains 20 pp of useful information on company's induced draft Bifurcator which provides instant, adequate draft and eliminates need for tall stack. Manufacturers' boiler code ratings are reduced to their common relationship of Btu/hr delivered to the steam. Also included are tables and charts on volume of flue gas for oil, gas and coal, selection data, performance data, and specifications. DeBothezat Fans Div., American Machine and Metals, Inc.

124 Roof Ventilators — Bulletin 3904, 8 pp, describes company's redesigned line of power roof ventilators. Construction, operation and design features of each of the four models in the line are described and performance data tabulated. Included are fan speeds and motor horsepower as well as certified delivery ratings up to ½-in. w.g. static pressure, installation drawings, dimensions. American Blower Corp.

WATER CONDITIONING

125 For Demineralization — Duolite Data Leaflet 35, about 11 pp, discusses properties and behavior of Duolite A-30, an intermediate base anion exchange resin for water demineralization. Chapters are devoted to physical, operating and performance characteristics. Chemical Process Co.

126 Water Conditioning — Publication 6210-C describes company's line of water conditioning equipment for process and power plant application. Covers demineralizers, hot process softeners, hot zeolite softeners, solids-contact reactors, deaerators, dealkalizers, filters, continuous blow-off systems, hydromatic single control valve, others. Cochrane Corp.

PUMPS, COMPRESSORS

127 Centrifugal Pumps — Bulletin P-3b describes custom-built, off-the-shelf, high-speed centrifugal pumps for handling clear liquids and fine slurries. Advantages are detailed and complete specifications listed on insert sheet. Ampco Metal, Inc.

128 Internal Gear Pumps — Condensed data on five new series of internal gear rotary pumps are provided in this illustrated folder. Pumps cover a broad range of services. Wayne Pump Co.

129 Pump Units — Catalog 107, 8 pp, contains information on Type-8U pump units, designed principally for handling heavy fuel oils in industrial and commercial oil burner service, as well as for the movement of any non-corrosive, highly viscous liquid with lubricating qualities. Charts and diagrams give complete dimensions, operating characteristics and pump and motor performance data. Tuthill Pump Co.

130 Fuel Oil Pump Sets — Up-to-date means for proper preparation of heavy oil for combustion is discussed and packaged fuel oil pump and heater sets described in Bulletin 15. Explains how these easy-to-install units come ready for operation and are designed to exceed minimum requirements of burner. Includes engineering data table showing recommended unit sizes for various burner capacities and approximate boiler horsepower ratings. Walter H. Eagan Co., Inc.

131 Reciprocating Compressors — Bulletin DS-361 is a 28-pp revised booklet on reciprocating compressors and includes ratings and data on company's 125- and 150-hp compressor and condensing units. Ratings on 60-, 75- and 100-ton condensers have been revised to conform with a new condenser which incorporates water heads at both ends. Roughing-in dimensions have been changed for units with motors of 30 hp and smaller. General compressor design features, and details on gas flow and lubricating system are provided, as well as complete capacity data and engineering specifications. The Trane Co.

ELECTRICAL

132 Guide to Voltage Regulation — Descriptive data on step voltage regulators are supplied in two new booklets — 12-pp Bulletin GEA-5752C and Bulletin GEA-6552. The illustrated booklets cover design features, applications, wiring diagrams and electrical data for 20 single-phase ratings and 77 three-phase ratings. Both brochures on step regulators plus one on induction feeder regulators are included in a single package "Your Guide to Profitable Voltage Regulation", GED-3133. General Electric Co.

133 Unit Substation Transformers — Bulletin 9004-B, 10 pp, contains information on unit substation transformers. Details of construction are illustrated and described and photos and cutaway views are included. Primary devices are also covered. I-T-E Circuit Breaker Co.

134 Indoor Power Center — Bulletin CS-1010 introduces a line of indoor power center transformers for 300 kva and below, completely self-contained units which are ideal for lighting circuits, small industry and commercial buildings. Engineering data, weight, dimensions and detailed schematic drawings of the units are included. Kuhlman Electric Co.

135 Rural Substations — Four basic arrangements of rural package substations are described in Bulletin GEA-5276C. Contains photos, diagrams and information on the following arrangements: simple radial with one feeder; simple radial with one to four feeders; radial with looping high-voltage circuit, and high-voltage selective for two incoming lines. Guide form specifications and information on the application of reclosers are included. General Electric Co.

136 Cable Installation Tips — Publication 19-606 is a 36-pp booklet on installation practices for company's interlocked armor cable systems. Booklet is devoted to photos showing terminations and splices; connections to switchgear, motors and plug-in bus; special installation problems; typical installations; and "before" and "after" illustrations showing the older wiring system side by side with the new interlocked armor cable system. General Electric Co.

137 Porcelain Insulators — Bulletin 304, 8 pp, covers standard wet and dry process porcelain insulators. Includes illustrations and specifications for screw type wire holders, spools, split and solid knobs, guy strain insulators, many others. Also provides data on housings and cable-supports for electric signs as well as specifications for transformer bushings. Universal Clay Products Co.

138 Fuse Link Applications — Bulletin FC5, 16 pp, describes a new line of fuse links, including EEI-NEMA Types K and T. Dimensions, time-current curves, construction features and application information are included. Company's method of packaging and labeling are also described. Line Material Co.

139 Emergency Light-Protection — How automatic battery charge control enables emergency lighting units to give greater protection against perils of lighting failures with less maintenance is told in illustrated Bulletin 5926. In addition to photos of the units, folder contains an operation chart demonstrating automatic charge control, and charts showing beam coverage, light intensity and protection time. Exide Industrial Div., The Electric Storage Battery Co.

140 Electronic Wire — Publication 19-586 describes high-temperature electronic wire for internal wiring of electrical and electronic equipment, meters, and panels, and available with thermoplastic, nylon, and silicone insulation. Complete specifications and application data are given. General Electric Co.

141 Electrical Boxes — Catalog 10, 24 pp, features descriptive information on a line of electrical boxes and cabinets, including junction boxes and pull boxes, conduit boxes, hinged cabinets, explosion housings, and fixture outlet boxes. Cutaway drawings are included, in addition to a section devoted to specifications and requirements of electrical enclosures. Spring City Electrical Mfg. Co.

BURNERS

142 Fuel Burning Systems — Six-pp Bulletin 1231-A describes a fuel burning system, consisting of a packaged combustion assembly utilizing gas, oil, or combination gas-oil firing for modernizing or converting existing boiler equipment, or for obtaining efficient operation from new equipment. Various elements of the fuel burning system are illustrated and typical installations pictured. Orr & Sembower, Inc.

143 For Lower Fuel Costs — This illustrated bulletin describes an industrial oil burner designed to effect a 30 per cent saving in fuel costs by using heavy No. 5 oil. A page of detailed specifications is included. Industrial Div., York-Shipley, Inc.

TOOLS, WELDING

144 Air-Motor Tools — Bulletin 61 concerns this manufacturer's new line of air-motor grinders and drills. Various models are pictured in action along with application suggestions and specifications. Versatility, power and other features of tools are stressed. Airetool Mfg. Co.

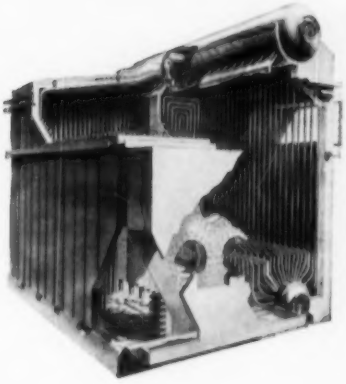
145 Stud Welding Standards — This pocket-size 36-pp booklet covers industry standards in arc welding studs, pins and tapped pads for stud welding. Concise and easy to read, booklet contains a complete index and reference to equipment and accessories used in stud welding applications. Each specification page lists size minimums and maximums. It details mechanical properties, chemistry, thread sizes, plating and annealing information and other data. K S M Products, Inc.

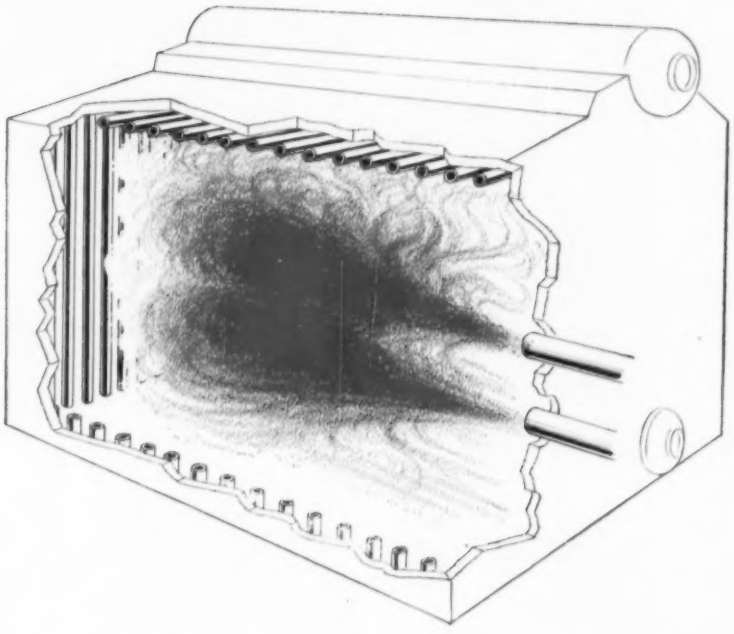
146 Welding Equipment — The complete line of Ampco-Weld resistance welding electrodes and accessories is de-

Another Feature of the FW Series "SC" Standard Boiler

EFFICIENT FIRING ARRANGEMENT

assures Longer, Trouble-Free Service





Simplified, schematic diagram showing firing arrangement of typical "SC" steam generator.

The furnace arrangement is carefully designed to permit excellent combustion of the fuel without impingement of the flame on any of the tube surfaces. This prevents harmful overheating and contributes to longer, trouble-free performance.

The rear wall of the firing chamber is over 19 feet from the burner wall, permitting long, horizontal flame travel. The flame envelope, as indicated above, occupies the major portion of available furnace space, greatly reducing ineffective or unused furnace volume. This same basic combustion principle has provided years of successful operation in many other types of FW boilers.

FW Series "SC" Steam Generators are available in capacities from 50,000 to 150,000 lb/hr, for pressures to 1500 psi and superheated steam temperatures to 950 F.

For further information, write for Bulletin B-55-4. *Foster Wheeler Corporation, 165 Broadway, New York 6, New York.*

OTHER FEATURES AT A GLANCE

- Completely water-cooled walls
- Unrestricted circulation
- All-welded casing
- Fully drainable superheater
- Efficient convection surface
- Bottom supported unit
- Steam purifying system
- Full insulation

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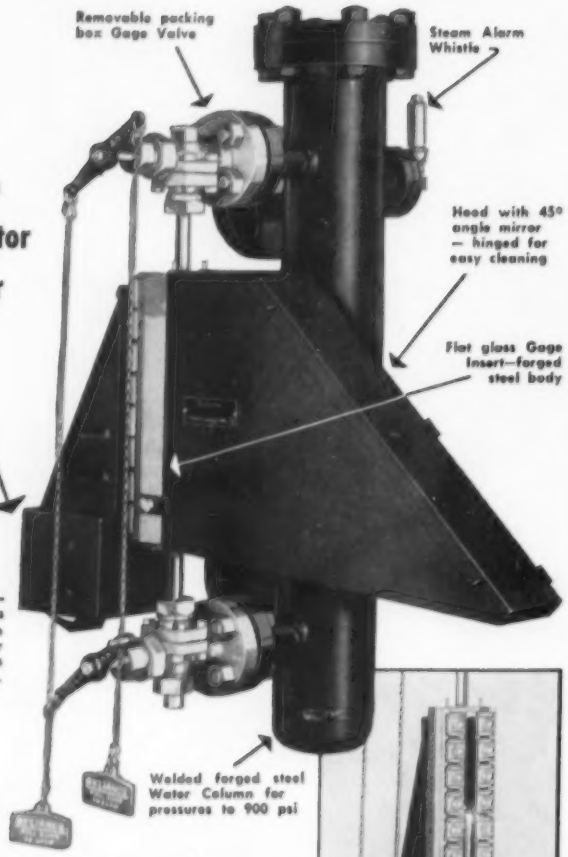
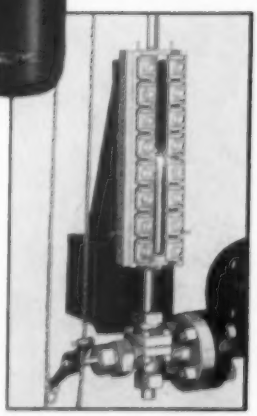
Reliance


Removable packing box Gage Valve
Steam Alarm Whistle
Mercury Lamp Gage Illuminator for extra-clear and distant reading
Hood with 45° angle mirror — hinged for easy cleaning
Flat glass Gage Insert—forged steel body
Recommended for conditions where gages are 25 ft. or more from operating level, or for extra bright meniscus image. See cut at right.
Welded forged steel Water Column for pressures to 900 psi



Reliance Water Columns for any working steam pressure assure you the utmost in dependability. Float-operated high and low water level alarms are available on columns for pressures to 900 psi. Reliance electrode-type Levalarms (to actuate visual or audible remote signals) for all pressures to 2500 psi. Standard and special columns, and complete line of safety gage equipment including the EYE-HYE remote reading gage. Write for condensed catalog Bulletin 316B.

The Reliance Gauge Column Company, 5902 Carnegie Ave., Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance®

BOILER SAFETY DEVICES

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scribed in 28-pp Bulletin RW-10. It provides applications, specifications and dimensions of standard welding tips, wheels, dies and holders. Also presents descriptive and illustrative data on holder-to-tip adapters, quick disconnect shutoff couplings, seam welder shafts and bushings. Ampco Metal, Inc.

147 Arc Welding Machines — Catalog 1340, 44 pp, contains information on arc welding machines and accessories for metal fabrication, construction and repair in plant, shop and field. Selenium rectifier and d-c motor generator arc welders for industrial welding, a-c and d-c engine driven arc welders for construction and maintenance, a-c transformer arc welders are among machines illustrated and described. Specifications for each machine, from ampere ratings to outside dimensions, are included. Air Reduction Co., Inc.

. . . *Outstanding Among This Month's Catalogs*

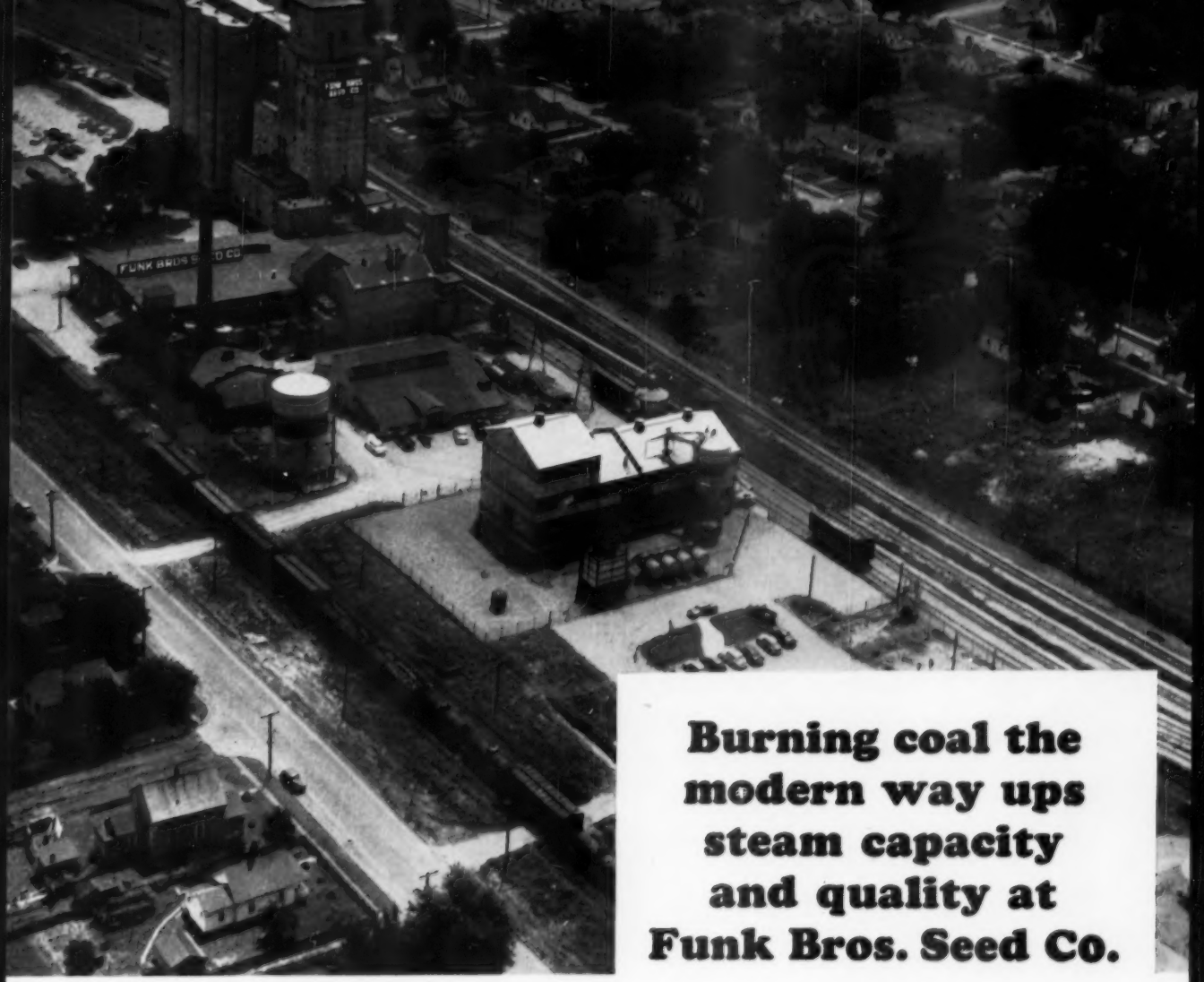
148 Unit Heaters—Bulletin 9417, 64 pp, is a vest-pocket edition of the Venturafin Unit Heater Handbook, containing specifications and operating characteristics as well as installation and application data for the Venturafin line. Pocket size, the handbook includes capacity tables, dimensions, engineering specifications, external ductwork suggestions, mounting heights, piping diagrams, pipe sizes, sound ratings and wiring diagrams. Also included is a typical selection problem together with a recommended solution procedure. Line drawings are used throughout. American Blower Corp.

149 AVA Cable Manual — Bulletin RMI 9-55 is a 30-pp manual on AVA cables — cables insulated with impregnated asbestos and varnished cable tape. Covers application and design data for three-conductor armored cables and single-conductor cable in conduit. Comparisons are tabulated to cover circuit length, capacity and regulation, economic and physical factors. A section is devoted to component parts. Engineering data on insulated cables is included to aid in calculating sizes and circuit data on common types of wire used in 600 v distribution systems. Rockbestos Products Corp.

150 Water Plant Automation — Technical Reprint T-148, a 10-pp article, tells how automation is finding wide application in boiler feedwater and process water treatment fields. Case histories are presented pointing out problems involved, methods of solution, and showing flow diagrams. Classification breakdowns of processes and equipment into three groups — mechanical, chemical and ion exchange — are included. Types of measurements required by the processes and types of control are classified, and various demineralizers available are indicated. Graver Water Conditioning Co.

INSULATION

152 Industrial Insulations — Full specifications for company's line of spun mineral wool industrial insulation products are presented in this 20-pp catalog. Lists standard sizes, thicknesses, and thermal



Burning coal the modern way ups steam capacity and quality at Funk Bros. Seed Co.

Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

As Funk Bros. Seed Co., Bloomington, Ill., increased the capacity of its soybean extraction plant 50%, the firm's old steam plant proved inadequate. Not only was it unable to produce enough steam, but steam quality was not suitable for best processing conditions. To remedy this situation, the company installed a new 26,000 lbs./hr. boiler, automatic controls, automatic coal and ash handling system and related equipment.

Today the steam plant at Funk Bros. requires only one man per shift, holding one of the most attractive operating jobs in the plant. Evaporation rates are in excess of 9 lbs. of steam per lb. of coal and there is adequate high quality steam for further expansion requirements. Also cleaner plant conditions resulting from this modernization have greatly improved community relations.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

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Advanced Designs—for economy, safety and performance—demanded by modern high pressure processing techniques. Examples: flow-blending chemicals and inhibitors, pulsing liquid extraction of metals, pumping liquid gases, metering D_2O to homogeneous reactors, charging pressurized-water atomic power systems, etc.

TWO BASIC TYPES OF DRIVE—
Conventional Crank Arm, where sine curve output is required, and Yoke Drive (illustrated) saving up to 25% of horsepower requirement, often a matter of a motor and gear reducer size in high pressure service.
DIFFERENTIAL PRESSURE HEADS—
hydraulically balance the pump piston using suction pressure. It is only necessary to power the pump for the difference between gallon-pounds of suction and the required gallon-pounds of discharge—plus about 10% for friction losses.
SPECIAL HIGH PRESSURE VALVES—
of ball-guiding cone seat type. Pressure drop is in direct ratio to ball rise (Patent applied for). Designs for pressures to 35,000 psi, down stream pumping, viscous materials (up to 30,000 SSU), difficult slurries.

CATALOG HP-1254 describes these *advanced designs.*

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conductivities for more than 20 types of heat and cold insulations for equipment and piping, and includes temperature-thickness recommendations for each. Also describes typical uses and provides application instructions. Baldwin-Hill Co.

153 Glass Insulation — Specifications for low temperature space installations are presented in 20-pp Booklet FL-101, which details latest recommended methods for installing Foamglas cellular glass insulation on walls, floors, ceilings and roofs of refrigerated spaces operating between −50 and 50 F. Lists suggested thicknesses as well as recommended adhesives, finishes, paints and other accessories for use with Foamglas in low temperature installations. Application data, specifications, and sectional drawings are included. Pittsburgh Corning Corp.

COOLING, HEAT EXCHANGING

154 Cooling Towers — Advantages offered by company's cooling towers for air conditioning and industrial service are described in 16-pp Bulletin 5.1.902. Structural and mechanical features are detailed, typical cross sections are diagrammed, and engineering data, dimensions and arrangements shown. Specifications and typical installations given. J. F. Pritchard & Co.

155 Cooling Towers — Bulletin 477-A, 12 pp, describes company's 3-B Series of cooling towers, including 24 popular sizes for almost every air conditioning and refrigeration need. Dimensions and approximate weights are indicated on a table, and selection tables, general specifications, construction features, applications, and photos of typical uses are included. Binks Mfg. Co.

156 Heat Exchange Equipment — Bulletin HE-1 specifically describes shell and tube heat exchange equipment. Construction features, general specifications and standard materials for the line of heat exchange equipment are outlined in tabular form. Heat Transfer Co.

157 Guide to Coatings — This 1957 Coatings Manual, 32 pp, highlights the stopping and preventing of rust on nearly all types of rustable metal. Illustrated in full color, this book contains information and recommendations to enable determination of specific coatings needed for the job. Basic principle of Rust-Oleum's fish oil penetration into pores of metal is illustrated. Application photos give new ideas for protecting girders, tanks, piping, boilers, roofs, other surfaces. Over 100 color chips show colors available in primers, short-oil and long-oil coatings. Galvinoleum, heat resistant, chemical resistant, and floor coatings are covered separately. Booklet also describes masonry coatings, clear liquid sealer and Surfa-Etch solution. Rust-Oleum Corp.

158 Inorganic Zinc Coating — An inorganic zinc coating for structural steel, tank interiors, and exteriors, towers and equipment which is unusually resistant to weathering, abrasion, salt and fresh water, solvents and petroleum products is described in this illustrated bulletin. General, physical and chemical properties are enumerated. Amercoat Corp.

SAFETY, FIRE PROTECTION

159 Combustion Safeguards — Bulletin SC-1006, 12 pp, describes operation and construction of company's automatic fire checks, which detect, localize

KEEP COAL-HANDLING COSTS DOWN *with help like this...*

- MOVES 10 TONS A PASS with standard blade... 15 tons with side wings
- TORQUE CONVERTER DRIVE... matches power and speed to the job requirements automatically
- 1,000-HOUR LUBRICATION INTERVALS... for truck wheels... eliminates daily greasing... gives 30 minutes' extra working time a day
- ONE-PIECE STEERING CLUTCH AND FINAL DRIVE HOUSING... insure perfect alignment, long life
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These are just five of dozens of reasons why an Allis-Chalmers HD-21 helps hold coal stockpiling costs down... contributes to a profitable operation. Now is the time to have these advantages working for you. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

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Straight through flow . . . minimum pressure drop.

2
Quick acting . . . opened and closed with less than one quarter turn of lever.

3
Self grinding rotating disc . . . assures tight seal.

4
Non-wedging action . . . cannot jam . . . parts move between parallel faces.

5
No lubrication required . . . hence no maintenance expense.

Our 50 years experience as valve manufacturers is at your disposal.

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and extinguish flashback in mixture supply line, where a combustible mixture of fuel gas and air is distributed to heating equipment, and safety blowouts which prevent flashback and relieve excessive flashback pressure in combustible mixture main supply piping. Photos, drawings, dimensional diagrams, and selection data are included. Selas Corp. of America.

160 Protective Equipment — This 32-pp illustrated catalog describes protective rubber gloves and sleeves for use in working with high voltages. The plastic-bound catalog tells of company's laboratory research and explains in detail how high voltage protective equipment is manufactured and tested. Gives instructions as to care and use and includes glove selector chart, ordering instructions, price list. Charleston Rubber Co.

161 Fire Extinguisher Systems — This 8-pp safety code for inspecting, recharging and maintaining fixed high pressure carbon dioxide extinguisher systems covers hydrostatic pressure testing methods, criteria for determining cylinder usability and safety precautions to observe when recharging cylinders. Fifteen inspection check-points, covering the inspection of hoses, valves, nozzles and cylinders, are also covered. Fire Equipment Manufacturers Association, Inc.

OTHER EQUIPMENT

162 Tube Expander Control — Bulletin 56-1 describes company's Model C Torq-Air-Matic, an air-powered boiler-tube expander drive and control. Advantages of precise tube rolling are discussed and features of the new device enumerated. Thomas C. Wilson, Inc.

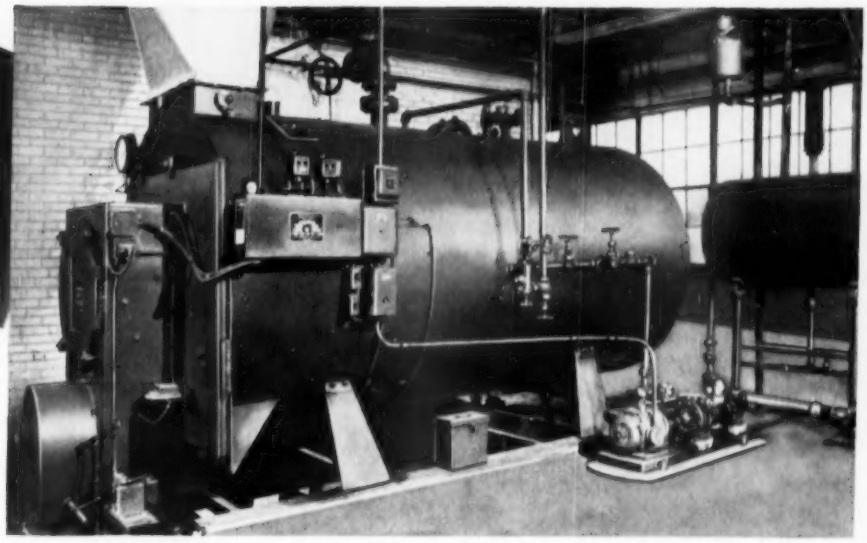
163 Tractors, Attachments — Three new bulletins are offered on tractor-scraper combinations and attachments. Usage information on company's HD-11G and HD-6G diesel powered crawler tractor shovels is provided in Forms MS-1137 and MS-1126. Matched attachments designed specifically for each model are shown through line drawings and catalog views. Four pull-type scrapers are featured in Form MS-1149. Each scraper model is shown in action. Catalog views of different models and illustrations of design features of the scraper line are included. Allis-Chalmers Mfg. Co.

164 Refractory Castable — Bulletin R-40 describes use of Kaocrete-32, a high temperature refractory castable, in boiler ashpits. A discussion of various methods of ash removal, along with maintenance problems peculiar to each, is presented. Four typical installations are detailed. Refractories Div., The Babcock & Wilcox Co.

165 Lubricating Oil Purifier — Bulletin TL-103, 6 pp, features operation and installation data on a turbine lubricating oil purifier designed to protect turbines by continuously removing water and sediment from lubricating oil. Diagrams of the system are included, as well as capacities, specifications and dimensions. The De Laval Separator Co.

166 Engine Applications — Eight engine case histories are presented in separate bulletins, with pictures and drawings illustrating applications of company's V-8 and V-12 engines of 540 to 4,000 cu in. displacement. Applications described include air conditioning, gas boosting, cotton ginning, generator sets, others. Le Roi Div., Westinghouse Air Brake Co.

"As an engineer, I know the advantages of SIMPLIFIED OPERATION in Packaged Boilers"



New 150-HP gas-fired Continental Automatic Boiler, installed in Progress Laundry, Dallas, Texas, reducing gas consumption more than one-third. Continental Boiler Distributor: J. P. Philibert, Fort Worth, Texas. Installation by H. C. Lohman Machinery Co., Dallas, Texas.

"In designing or modernizing a boiler plant, simplicity of equipment usually means important savings in both labor and fuel. That's just another way of saying it pays to insist on Packaged Boilers.

"Controls are simplified and dependable, and they require practically no maintenance. Cleaning is simplified by easy access to burner and tubes. Air atomizing reduces burner maintenance to a minimum.

"Best of all, the responsibility for this simplified operation rests with one firm only — the manufacturer of the unit. So if we ever do need help, we know exactly where to get it."

For details on the Continental Automatic Boiler, send for Bulletin BE-3

Six Reasons Why it Pays to Buy a CONTINENTAL Automatic Boiler

* Guaranteed 80% efficiency . . . Fire-tested before shipment . . . Range, 20 to 500 hp.
* Simple, practical two-pass design, for uniform flow of combustion gases through all return tubes.
* Maximum radiant heat transfer achieved by "Spinning Gas" technique for thorough mixing of air and atomized fuel.
* High-CO_2 and low-temperature stack gases — proof of high combustion efficiency.
* Free, rapid water circulation improves heat transfer, keeps heating surfaces clean.
* Easy access to furnace and all return tubes. Refractory baffles and brickwork are not required.

BOILER ENGINEERING & SUPPLY COMPANY, INC.

3 Manavon Street, Phoenixville, Pa.

A HALF CENTURY OF BOILER MANUFACTURING EXPERIENCE

The Continental AUTOMATIC BOILER

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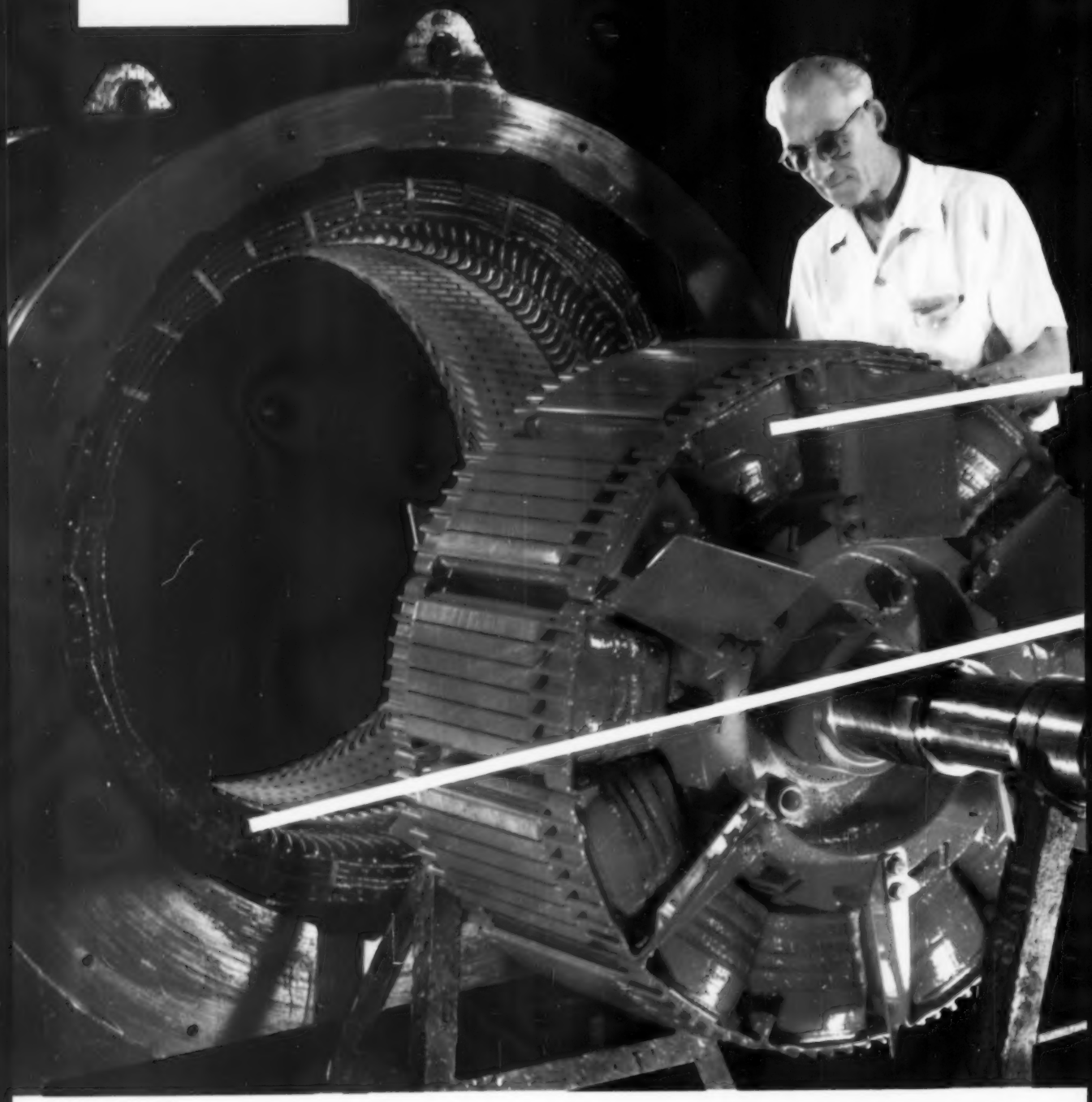
ONLY Allis-Chalmers



ALLIS-

MOTORS are "double protected"

New Integrated Field Coils Plus *Silco-Flex* Stator Insulation Provide Superior Motor Protection . . . Under Any Operating Conditions

1

Integrated Field Coils are bonded in heat-stabilized resins, enclosed in a resin-impregnated sheath of oriented glass fibers and bond-locked on the pole structure . . . dimensionally stable to withstand heating and thermal shock, vibration and fatigue at elevated temperatures . . . sealed throughout against atmospheric contaminants and fully protected against destructive forces.

2

***Silco-Flex* Insulation** provides a homogeneous, void-free insulating wall of silicone rubber on stator coils. It is unexcelled in life and thermal stability at high temperatures . . . resistant to most chemicals, water, weather . . . outstanding in flexibility and resilience . . . able to withstand abrasion and corona . . . resistant to physical and mechanical forces.

Exclusive Allis-Chalmers "double protection" is available on large electrical machines with operating temperatures through Class B range.

Silco-Flex is an Allis-Chalmers trademark.

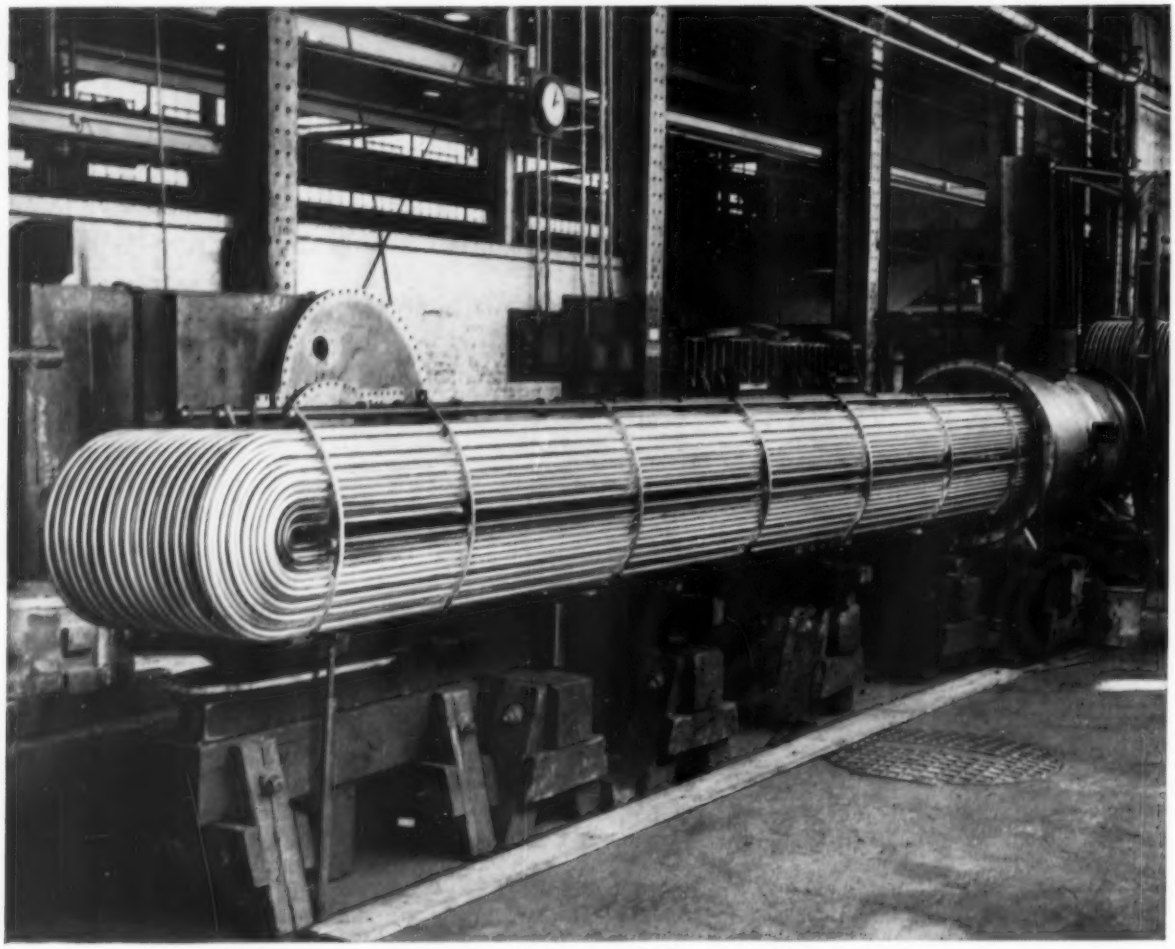
For more information on these quality insulation systems contact your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin for Integrated Field Coil Bulletin 05R8525 and *Silco-Flex* Insulation Bulletin 05R8341.

Allis-Chalmers "Double Protection," with integrated field coils and Silco-Flex stator coil insulation, adapts this 600-hp, 2300-volt, 600-rpm synchronous motor to the most severe operating conditions.

CHALMERS

A-C ALLIS-CHALMERS

A-5221



U-Bend Tubes of Anaconda Arsenical Admiralty-439 assembled in a bundle for a horizontal feed-water heat exchanger by The Griscom-Russell Co., Massillon, Ohio.

Arsenical Admiralty U-Bend Tubes make a compact power station feed-water heater

This compact tube bundle contains 436 Anaconda Arsenical Admiralty-439 tubes, ⅝-inch OD x .049-inch gage, averaging 45 feet long. The bundle is now operating in a power station feed-water heater.

The American Brass Company is constantly studying corrosion problems affecting condensers and heat exchangers—and is a leader in the development of alloys to help meet these problems. Arsenical Admiralty-439 is but one of its many contributions in the field.

Full Range Available. Anaconda heat exchanger and condenser tubes are made for all sizes and kinds of shell-and-tube, submerged, spray-tower, and finned-atmospheric heat transfer equipment – for operation at elevated temperatures in conformance with ASME standards for allowable stresses.

Technical Assistance. The Technical Department of The American Brass Company is regularly helping manufacturers, power companies, marine operators, petroleum and chemical companies to select the correct tube alloy for many types of condensers and heat exchangers. This service is available to you without obligation. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

3783

ANACONDA®

Tubes and Plates for

Condensers and Heat Exchangers

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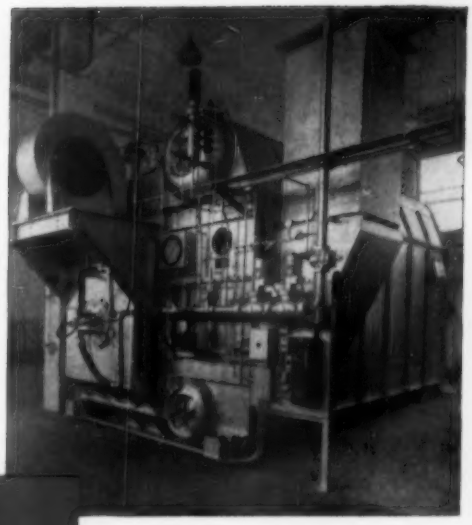
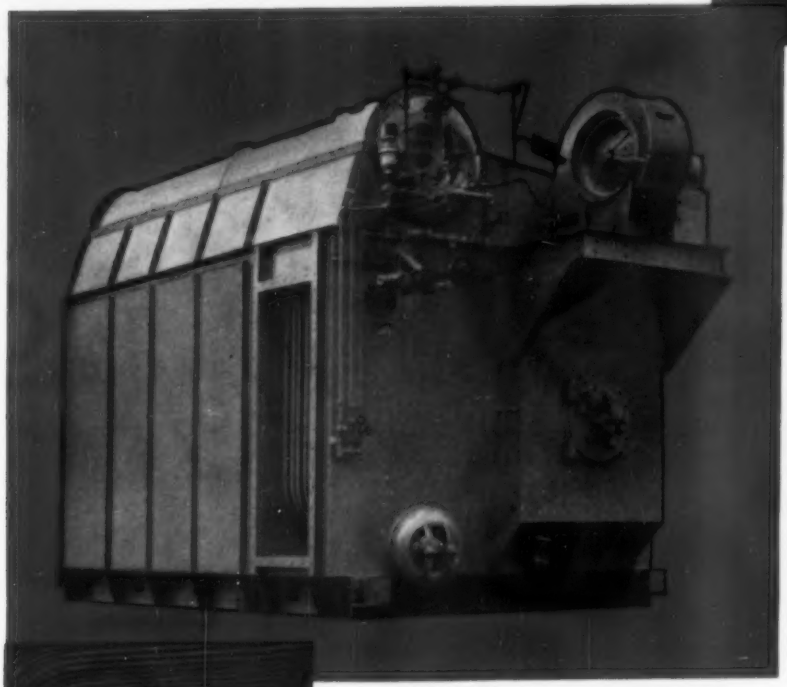
packaged power for limited space requirements . . .





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Type D-K

a comparatively wide and short boiler incorporating the proven efficiency and economy of Keeler Water Tube Steam Generators in a compact, low cost unit

Where boiler room space is definitely limited, the KEELER TYPE D-K Water Tube Package Steam Generator is the answer to your problem! It's a comparatively wide and short boiler for use where long boilers of other types cannot be accommodated.

KEELER TYPE D-K Package Boilers are made in oil or gas fired units with capacities from 8000 to 45000-lbs. of steam per hour—standard design pressures of 200 psi and maximum design pressures of 500 psi. The furnace sides, roof and floor, as well as front and rear walls, are water cooled and insulated. The complete "package", ready for quick hook-up and operation, includes all burning equipment, controls, safety devices and accessories.

For a low first cost, low operating cost outfit, you'll want the full particulars on this compact Package Power Plant! Write or phone . . . there's a KEELER representative at your service in your locality.

Write For Bulletins

No. DK-1: Type DK Package Boilers
No. F-14: Type CP Package Boilers
No. M-2A: Type CPM Package Boilers
No. MK-1: Type MK Boilers

The Seal of Quality in Water Tube Boilers

— ESTABLISHED 1864 —

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— OFFICES IN PRINCIPAL CITIES —

KEELER WATER TUBE Boilers

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Now you can buy a Bailey-built HEAT PROVER Analyzer

Flue gas analysis with a Bailey HEAT PROVER Analyzer at a furnace stack. Per cent oxygen and combustibles is shown continuously.

CONTINUOUS READINGS OF OXYGEN AND COMBUSTIBLES

The famous Cities Service HEAT PROVER Analyzer, formerly available only on loan, is now manufactured by Bailey Meter Company, and you can buy one outright. With this handy portable instrument, you can easily monitor the per cent of oxygen and combustibles in gases.

The continuous readings from a Bailey HEAT PROVER Analyzer enable furnace, kiln, and engine operators to correct combustion variables before costly losses are incurred. Although it weighs a scant 25 pounds, the HEAT PROVER Analyzer is the key to maximum combustion efficiency. With it, the operator can determine the proper proportion of fuel to air at any time.

The two meters on the analyzer show per cent by volume of oxygen and combustibles on either a 20% range span or a more sensitive 4% range. Temperature of flue gases in degrees Fahrenheit is also shown.

Compared with involved, time-consuming Orsat measurements of flue gases, this new portable analyzer offers these advantages:

1. Simultaneous direct readings of oxygen and combustibles.
2. Negligible time lag between combustion change and reading change.
3. Continuous sampling, analysis, and readings.
4. Convenient measurement of temperature.

Ask your Bailey engineer how you can use this instrument to increase combustion efficiency. Or, write today for more information on how this new Bailey HEAT PROVER Analyzer can pay for itself practically at once. G-39-1

Instruments and controls for power and process

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BAILEY METERS

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Unretouched photo of dissolved oxygen attack in steam condensate return lines.

DEPOSIT OF NO RETURN

The "growths" you see on the interior of this condensate return line are known as tubercles. Beneath each tubercle is a cavity or pit in the metal surface—the result of concentrated, localized attack by the corrosive water. Water containing dissolved oxygen has converted metal on the pipe's interior to iron oxide, causing a buildup of corroded material. The velocity of the water flowing through the line is not sufficient to remove the tubercles, so they continue to grow larger and larger.

Dearborn's FILMEEN* prevents this corrosive attack by forming a continuous, monomolecular film on the interior surface of the pipe, protecting it against both oxygen and carbon dioxide corrosion. FILMEEN provides a protective, non-wettable barrier between treated steam, or condensate, and metal pipe surfaces.

FILMEEN is only one of many Dearborn water conditioning products scientifically developed to control specific corrosion problems. Others eliminate scale, sludge, carry-over, and similar difficulties.

Power engineers in leading industrial and commercial plants place their confidence in Dearborn's 70 years of experience in water chemistry. They have found the answer to the demand for complete plant protection in Dearborn Supervisory Service—a properly balanced water conditioning program which combines quality products with correct, technically supervised control methods and test procedures.

Let a Dearborn Engineer survey your plant and recommend the type of water control program best suited to your requirements.

Illustrated Booklet gives all the facts on Dearborn Water Conditioning Program. The coupon is for your convenience.

**FILMEEN is the trade-mark of a corrosion-inhibiting compound patented and produced exclusively by Dearborn Chemical Company. U. S. Pat. No. RE 23614.*

Dearborn®

...a leader in water conditioning and corrosion control since 1887

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PG, Chicago 54, Ill.
Gentlemen:

☐ Send my copy of Dearborn Water Conditioning Program.
☐ Have a Dearborn Water Treatment Engineer call.

Name.....

Company.....

Address.....

City.....*Zone*.....*State*.....

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CONSTRUCTION NEWS

Yuma, Ariz. — Three electric utility companies, the California Electric Power Co, Riverside, Calif., Arizona Public Service Co, Phoenix, Ariz., and the Imperial Irrigation District of El Centro, Calif., have announced a joint program in the development of a two-unit steam-electric generating station and power pool on local site recently selected near here. New facility, to be known as the Yuma Axis Steam Plant, will have a number-one unit, to cost about $12,000,000, under construction by early 1957 and to be completed in the spring of 1959. A second unit of similar capacity and cost will be built at the same site at a later date.

Barstow, Calif. — California Electric Power Co, 3771 W Eighth St, Riverside, Calif., has announced plans for the construction of a new steam-electric generating station on site selected near here. A steam-electric generating unit with initial capacity of 60,000 kw will be installed at an approximate cost of $10,000,000. Work will begin on the project sometime in the spring of 1957 for completion early in 1959. This is part of a large expansion program currently in progress to expand company's generating and transmission facilities.

Denver, Colo. — Public Service Co of Colorado, 900 15th St, has announced a construction budget for 1957 in excess of $30,000,000, the highest in company history for any previous year. This is $5,500,000 more than company expended in 1956. Largest of the capital additions in the new budget is $11,219,000 allocated to the continuation of construction of two new power plants now under construction at Cherokee Power Station, Denver, Colo., and the Cameo Power Station, at Grand Junction, Colo. Company has expended more than $110,000,000 on expansion in the past five years.

Miami, Fla. — Florida Power & Light Co, 25 S Second Street, has plans under way to increase generating capacity by 100 per cent within the next five years, to keep pace with the tremendous demand for power in the areas which it serves. Present construction budget ending in 1961 will approximate an outlay of $496,000,000, over the past ten-year period. Original program estimated to cost $332,000,000, was raised to $435,000,000, before the latest increase. Company will have a generating capacity of 2,080,000 kwh by the end of 1961, in sharp contrast to 1,000,000-kwh capability with present installations.

Cordelle, Ga. — The Crisp Power Commission has announced plans for the construction of power generating station on local site near here. It is reported to be the first power generating station in the country to be planned as a combined gas turbine-steam turbine generator unit. Preliminary engineering work is under way and construction work will get under way soon. Both the gas and the steam turbine generators will be built by General Electric Co.

New Orleans, La. — Lousiana Power & Light Co, 142 Delaronde St, is arranging financing in the amount of $20,000,000, proceeds of which will be used for expansion and improvements in plants and systems, including generating facilities, power substations, transmission lines and other work. Company has filed a registration statement with the SEC covering proposed bond issue. Expansion plans in 1957 call for a budget of approximately $28,000,000.

Boston, Mass. — Boston Edison Co, 39 Boylston St, has announced plans for a major expansion of company's generating facilities and transmission lines through the coming five-year period, which will involve the expenditure of $160,000,000. Company proposes to spend $95,000,000 on new transmission and distribution lines and $65,000,000 on new generating facilities. Major items in added generating facilities will include the completion this year of a new 140,000-kw steam-electric generating unit at company's Mystic Station, a second unit of like size in 1959 and a third in 1961 that will possibly be larger than two previous installations.

Boston, Mass. — New England Electric System, 441 Stuart St, has plans under consideration for the construction of a new atomic powered, electric generating plant with an initial capacity of 200,000 kw. Preliminary studies are now being made to determine the most appropriate reactor, size and location of the new plant for the integration of its output with company's hydro and steam resources. Work on new plant will begin as soon as engineering plans are available and site of new plant is determined.

Jackson, Miss. — Mississippi Power & Light Co, Lampton Bldg, has filed a request with the SEC for authority to borrow $9,000,000 in the form of short term bank notes, proceeds of which will be used for new construction and expansion of company's generating facilities, transmission lines and sub-stations. Company's plans for 1957 include the expenditure of more than $14,000,000 for such expansion and approximately $20,000,000 in the same direction in 1958.

Reno, Nevada — Sierra Pacific Power Co, 21 E First St, has arranged financing in the amount of $3,000,000, through sale of bonds, proceeds of which will be used in part, for expansion and improvement in power plants and system, including power substations, transmission lines, etc.

Syracuse, N. Y. — Niagara Mohawk Power Co, 300 Erie Blvd, has plans under way for the construction of two new steam-electric generating units at its Dunkirk Station. Both units will have an initial capacity of 200,000 kw and are scheduled to be placed on line late in 1959. Twin units are part of company's western division's three-year expansion program reported to be in excess of $75,000,000. When completed, the two units will boost Dunkirk Station's generating capacity from 204,000 kw to more than 604,000 kw. Niagara Mohawk's steam generating capacity will be increased to more than 2,700,000 kw by the end of 1959.

Embreeville, Penna. — General State Authority, 18th and Herr Streets, Harrisburg, Penna., has announced a major expansion and improvement program of Embreeville State Hospital. Plans include a new building for the senile patients, to cost approximately $2,500,000; one for disturbed patients at $2,000,000; and another for acute patients, involving an expenditure of another $2,500,000. Alteration work includes new and added electrical distribution and street lighting as well as repairs and improvements in the boiler house and steam distribution systems. Total estimate of expansion and remodeling program will approximate more than $8,000,000. H. F. Lenz Co, Johnstown, Penna., construction engineer.

Pittsburgh, Penna. — West Penn Power Co, 14 Wood St, has announced plans for the construction of a second large steam-electric generating unit at company's Armstrong Power Station, near Kittanning, Penna. Installation will include a new generating unit with an initial capacity of 156,250 kw to supplement station's first generating unit of 165,000 kw which is now being repaired and reconstructed for completion in late spring of 1958. No engineering or construction schedule of the new unit has been set but average time for the installation of such a unit is from two to three years. Two turbine generators at Armstrong Station will be the largest in the West Penn Electric System and when placed in service will expand company's total plant capability to more than 1,250,000 kw.

Memphis, Tenn. — The City of Memphis, Light, Gas and Water Division, has arranged financing in the amount of $163,245,000, for permanent financing of municipal 750,000-kw electric generating plant currently under construction, in what is reported to be the largest transaction by a city for the construction of electric generating and distribution facilities. New plant will be in operation by October 1958, and financing will cover cost of installing original three generating units of six planned for the project over the next ten years. The remaining three installations will be installed, as needed, over a five-year period ending in 1965.

Corpus Christi, Tex. — Central Power & Light Co, 120 N Chaparral St, has announced construction of new steam-electric generating power plant at Mission, Tex. Plant will have an initial capacity of 66,000 kw. Preliminary work is already under way and Austin Building Co, 1000 Singleton St, Dallas, Tex., has been awarded contract for $1,550,409 for general construction work, including lines and earthwork, for the plant.

San Antonio, Tex. — The Public Service Board of the City of San Antonio, Navarro and Vilita Streets, in line with plans for new additions and improvements to municipal power plant and distribution system has authorized plans for additional underground electric cable lines at a reported cost of $500,000; installation of electrical distribution transformers at a cost of $250,000 and gas line replacements at a cost of $250,000. Work will be supervised by city's own engineering department.

Fairmont, W. Va. — Monongahela Power Co, Watson Bldg, an operating company of the West Penn Electric System, Pittsburgh, Penna., has announced a three-year expansion program of company system which serves central West Virginia. Construction budget of more than $25,000,000 has been authorized for extensions and improvements in power generating facilities for increased output, power substations, transmission lines and other operating facilities.

INCREASED PRODUCTION *with* GREATER FUEL ECONOMY

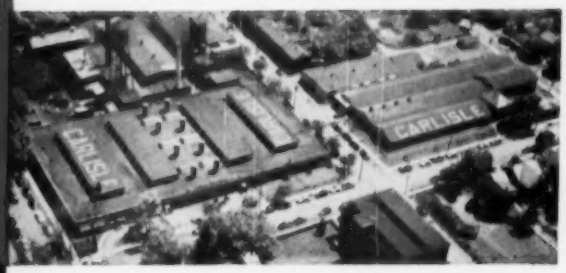
Smokeless Operation

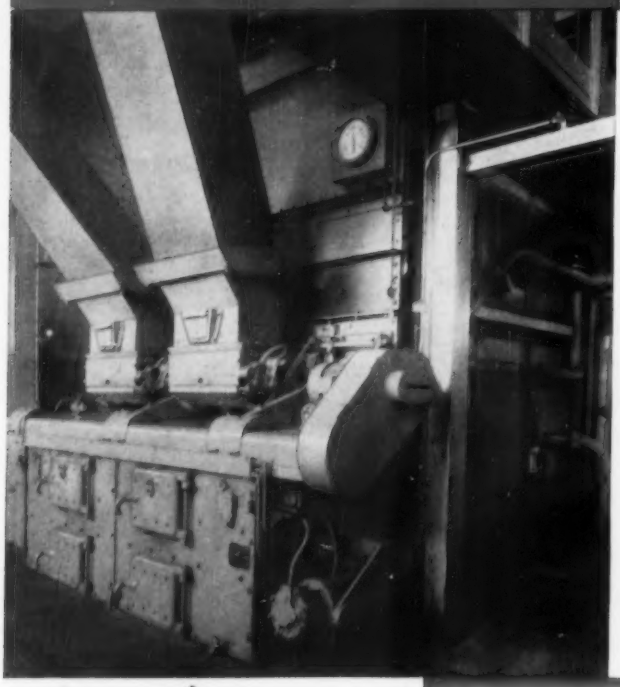
DETROIT ROTOSTOKER TYPE C-C

(Continuous Cleaning)

at Carlisle Tire and Rubber Division

CARLISLE, PA.





It is not uncommon for the Detroit RotoStoker, Type C-C to make fuel savings ranging from 10% to 25%. Where process steam is used in production, as in this plant, fuel economy is usually accompanied by a substantial production increase.

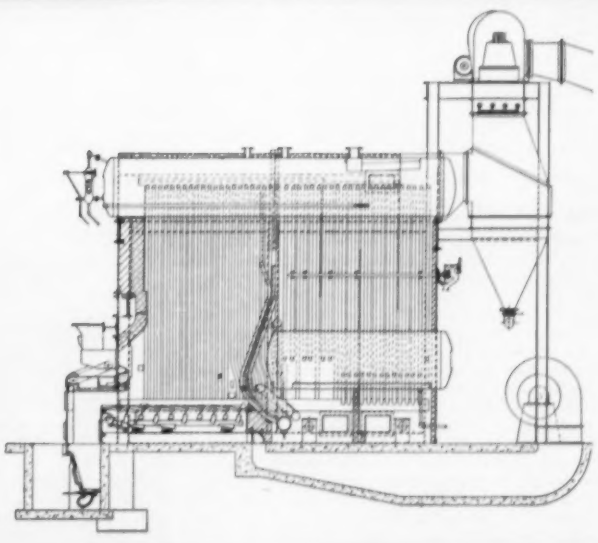
In addition the Type C-C provides smokeless operation at light loads as well as at full capacity—important in built-up areas.

Other advantages of Type C-C are:

- **Continuous uninterrupted steaming.**
- **Ample capacity and high availability.**
- **Quick response to load fluctuations.**
- **Fuel feeders and distributors handle high moisture coals without clogging.**
- **Available to develop 5,000 to 75,000 lbs. of steam per hour.**
- **Easily applied to new or existing boilers.**
- **Low Maintenance.**

Detroit RotoStoker Type C-C (continuous cleaning) in the plant of Carlisle Tire and Rubber Division of Carlisle Corporation. This unit has a capacity of 25,000 pounds of steam per hour. Either West Virginia or Pennsylvania 13,500 BTU coal is used.

Keeler Type CP Boiler with Detroit RotoStoker Type C-C. Ashes discharge at front, are removed by a conveyor. No basement is needed.



DETROIT STOKER COMPANY

MAIN OFFICE AND WORKS
MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

For more data circle 528 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 115–116 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—STORED ENERGY UNIT works magne-blast circuit breakers

Designed to operate magne-blast circuit breakers with metal-clad switchgear, this stored energy mechanism receives its energy from a small operating motor. It is described as suited for general application on industrial and electric utility power systems, and comes in voltage ratings from 4.16 to 13.8 kv, interrupting ratings from 150 to 750 mva. It is suggested for installations where it is desirable to provide only a limited source of a-c or d-c closing power.

According to company, this mechanism makes unnecessary a relatively large operating battery or control power transformer, and closing rectifiers which would otherwise be required. Tests are reported to show that, when operating a magne-blast breaker, this device will surpass the mechanical life requirement of 10,000 operations specified by industry standards. Breakers equipped with it will operate in existing up-to-date metal-clad equipment interchangeably with a-c or d-c solenoid operated breakers, it is noted. General Electric Co.

2—RIGHT ANGLE GEAR DRIVE for boiler tube expanding

This heavy-duty right-angle gear drive, for boiler tube expanding, utilizes roller bearings to minimize friction, it is

pointed out, and therefore cuts down power losses through the unit. Its outer case is forged steel. The new drive is available in ½-, ¾- and 1-in. sizes. Lagonda Div., Elliott Co.

3—SMALL TRANSFORMERS are higher rated and more quiet

Type M transformer ratings through 50 kva single-phase and 150 kva three-phase are offered to meet low noise level requirements of hospitals, commercial buildings and similar plants. The lightweight dry-type transformer line is announced as dust proof, drip proof, and of fire resistant construction, and the new ratings are designed for a noise level of approximately 45 decibels or below. Suitable for indoor and outdoor applications, the transformer's exposed core type of construction permits no resonance, it is explained, since there is no metal enclosure. Additional ratings of the Type M construction parallel company's present Type D line of transformers plus extra combinations of taps above and below normal and 240-v three-phase secondaries. The small-size line of transformers is available in 25, 37½ and 50 kva single-phase; also in 30, 45, 75, 112.5, and 150 kva in three-phase ratings. General Electric Co.

4—HIGH TEMP LUBRICANT has low carbon content

The problem of oil carbon deposits in machines operating at high temperatures is reported to vanish when Keystone 49 Light is used. This oil is claimed to resist oxidation, sludging and breakdown when subjected to severe laboratory and field tests. While developed primarily for air compressor use, the low carbon content and anti-gumming features of the lubricant suggest its use for such applications as: ring bearings in electric motors; multi-plate friction clutches; plastic molding heat transfer systems; drying oven conveyor chains; and textile tenter frames. Keystone Lubricating Co.

5—SELF CONTAINED SEAL for pumps, reduction units

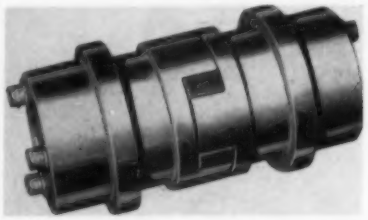
The BA12A-10 is introduced as a self-contained, compact seal for use in all types of jet water pumps, oil pumps, reduction units, other equipment. Manufacturer says it can be used on any rotating shaft to seal any liquids that will not attack the Buna-N flexible parts or the brass metal parts. The face of the seal, designed to stand high face loading and heat, is made from filled true carbon to prevent porosity. A roll designed bellows is incorporated to allow greater travel. This seal is recommended by manufacturer to operate against pressures to 100 psi, is available for ⅝- and ¾-in. diam shafts with general operating limitation of 212 F with shaft speeds to 1000 fpm. The Garlock Packing Co.

6—FRICTION TAPE offers high strength superior adhesion

Among performance characteristics announced for Bull Dog Premium Brown Friction Tape are superior adhesion, high tensile strength, outstanding weathering, high dielectric strength, and superior aging and non-raveling. It is packaged in individual cartons with a transparent protective over-wrap. It is available in size No. 8, ¾ in. by 60 ft, with 100 cartons per shipping case. Boston Woven Hose & Rubber Co.

7—FLEXIBLE COUPLING is radially removable unit

The Type RRL is described as a radially removable coupling providing a simple means of disconnecting two units without axial movement of shafts. This coupling is reported to simplify maintenance and be ideal for applications where



driven equipment, such as a pump, must be disconnected while driving unit continues to operate. All that is claimed necessary in such cases is to disassemble the coupling itself. Manufacturer says the coupling is rugged and simple in design, and because the load is transmitted by compression of the one-piece load cushion, there is no wear on the metal jaws. Ratings range from 7.5 to 40 hp at 1800 rpm; bores are from 1⅜ to 2¼ in.; outer diameters from 2⅝ to 5 in.; overall length, from 6⅛ to 7⅝ in. Lovejoy Flexible Coupling Co.

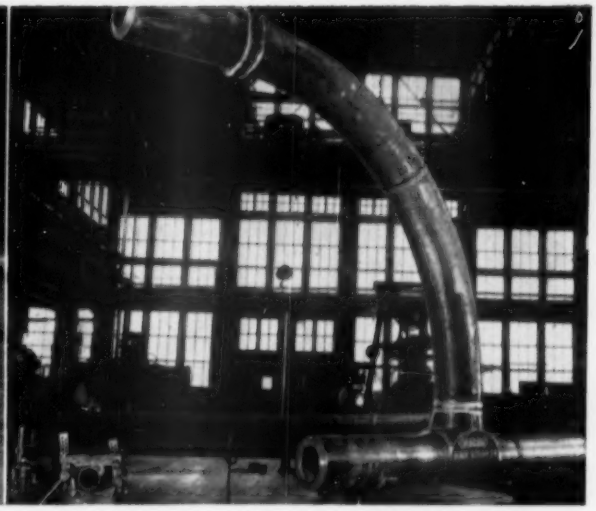
8—SOLDERLESS LUGS with variety of conductor diameters

The ShureLug line of solderless lugs comes in single barrel, double barrel, and triple barrel models and in one-hole, two-hole, and four-hole mounting styles. Conductor diameter capacities range from 14 sol. to 1000 MGM. ShureLugs for No. 4 and larger cables are available with hex head or Allen head screws. Smaller sizes have fillister head screws. The lugs are cast in one piece from a copper alloy. According to company, the lugs provide great strength, excellent conductivity, stable operating characteristics. O. Z. Electrical Mfg. Corp.

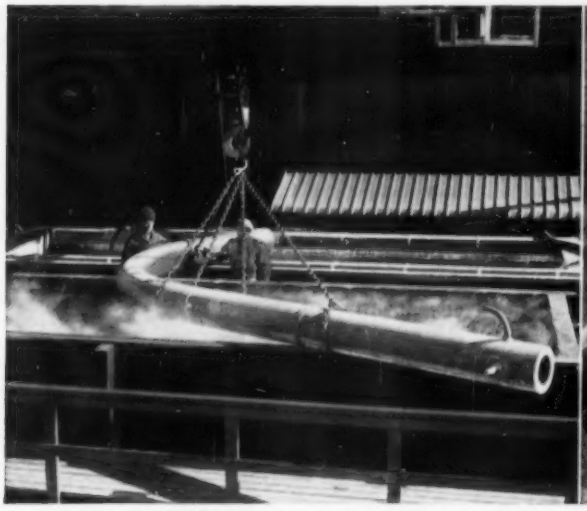
9—FEED WATER REGULATOR is balanced flow type

The Type P, a balanced flow, feed water regulator for high-duty steam generators, is designed to match feed-water input to steam output, regardless of load conditions, and to hold drum level within close limits, despite changes in load or feed-water pressure. Control is modulated by three influences — drum-water level, feed-water flow and steam flow. According to company, the two flow influences are obtained from primary elements of flowmeters. Each acts on a force-balance transmitter which

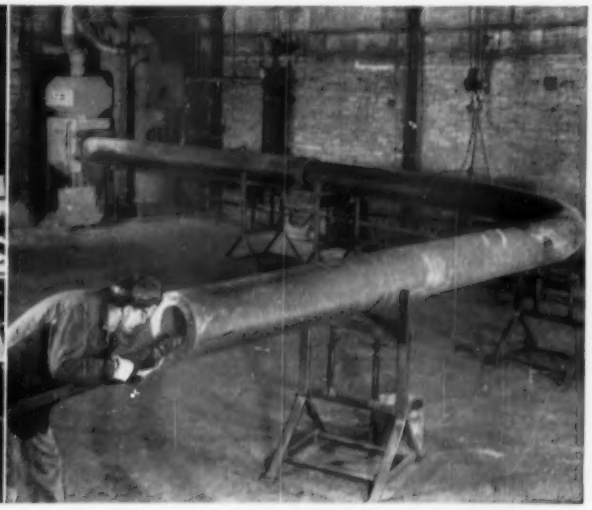
Crane's skilled shopmen bend 17¾" O.D. pipe with 3¼" wall. Pipe bend is for steam service—1970 lbs. at 1050 deg. F.



Experienced Crane welders have welded the bend (see photo 1) to header. Pipe is 2¼% chrome, 1% moly, alloy steel. Unit shown weighed 15,000 lbs.



Pipe bend fabricated by Crane is being pickled as part of cleaning procedure. Pipe is chrome-moly alloy—2.539" wall thickness; 13.578" O.D. Unit weighs 9050 lbs.



Pipe shown at left also was shot-blasted. Combining pickling and shot-blasting assures maximum interior cleanliness.

Let CRANE fabricate your heavy-wall pipe

Do your high pressure-high temperature piping specifications call for bending and fabricating pipe of greater wall thicknesses than the maximums shown in Schedule 160 thicknesses?

Crane shops for years have been processing heavy-wall pipe ranging in thicknesses up to 3.750"; in O.D. pipe sizes from 11.690" to 21.000"!

Crane facilities include bending, welding, upsetting, machining, full furnace stress-relieving or heat treating, radiographic inspection, and thorough interior cleaning.

All Crane facilities are housed under *one* roof for fastest service—and controlled and operated under *one* responsibility. Thus, you are assured of traditional Crane quality in materials, engineering supervision, and skilled shopmanship—that effect important economies in erection, operation, and maintenance for years to come.

For prompt consultation write to address below.

CRANE FABRICATED PIPING

VALVES • FITTINGS • PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

For more data circle 529 on Post Card

sends an air impulse to a balancing (combining) relay.

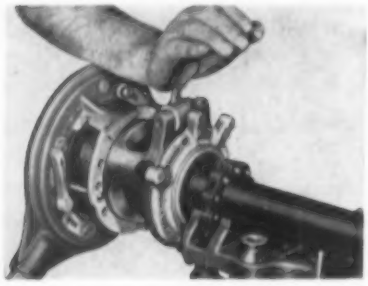
Transmitters can be mounted without regard to each other, it is noted, because they are not mechanically linked. Drum-level impulse to balancing relay is sent out by a pressure-compensated pilot operated by a thermostatic tube. A slider adjustment on each transmitter permits modifying the output range to give a rising, lowering or practically constant drum water-level characteristic. Balancing relay permits either bias adjustment or 1-to-1 combining of three control influence. The system can have diaphragm or piston operated control valves having ports to match various plant operating conditions. Almost any desired opening or closing force can be provided. The auto-manual control station permits remote manual control of feed valve. Having no "seal" position, transfer from manual to automatic and vice versa is fast and bumpless, company notes. Copes-Vulcan Div., Blaw-Knox Co.

10—DUST COLLECTOR picks up the metal and stone dust

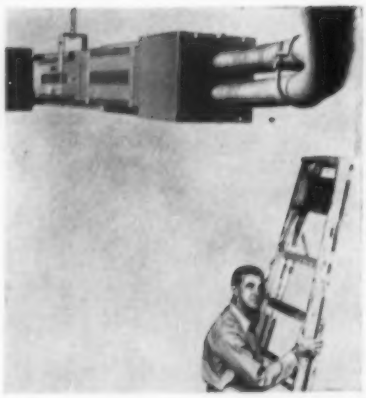
It isn't necessary to risk damage from metal or stone dust in bearings, commutator slots, switchgears, or air gaps when resurfacing commutators, according to manufacturer of this new dust collector. It utilizes an industrial vacuum attachment to pick up such dust before it can cause trouble. It mounts on either grinder, generator frame, or motor. Simple and compact, it is readily attached to company's industrial vacuum cleaner hose. The unit includes adjustable nozzle with brush and mounting brackets. The nozzle brush loosens dust and the vacuum picks it up — while grinding job is being done. Form A-3b gives details. Ideal Industries, Inc.

11—WORKHOLDER helps provide straight pipe threads

The TC (true-centering) Workholder assures pipe threads which are always straight and true, according to manufacturer. An improvement on company's new Ridgid 65 Pipe Threaders, this



workholder can also be put on previous models. With it, there is a perfect thread every time, it is explained, because all three workholder jaws close at one time — even if pipe is over or under size. You simply pre-set the workholder cam plate to desired pipe size, which adjusts the three jaws in a single mechanical action. When the threader is on the pipe, the jaws tighten as this three-jaw action is continued by pump of palm of the operator's hand on the cam lever. Easy adjustment for drip threads is also noted. The Ridge Tool Co.



12—PLUG-IN BUSWAY with low impedance characteristics

Uni-Bus Power Distribution Systems are announced as combining low-impedance characteristics and plug-in construction. Their flexible construction contributes to savings in layout and installation. Special plug-in units and interlocked plug-in opening covers are designed for maximum safety during installation and relocation. Bus bars are covered until plug-in devices are fastened to busway over plug-in opening. Interlocked contacts operate so that it is impossible to interrupt the current with them, it is stated — the switch or breaker must open the circuit before contacts can be removed from the bus bar and the cover of the unit opened. Although live parts are not exposed when cover is open, contacts in open position are visible.

Corprene separators and liners provide a resilient mounting which clamps the bars sufficiently to permit vertical mounting. It is noted that at each joint, phase collection provides load equalization and high short circuit strength with approved ratings to 50,000 amp RMS. Flexible connectors consist of two attachment boxes joined with flexible conduit and cable. Busways come in copper or aluminum with single run ratings of 225, 400 and 600 amp in two-, three- and four-pole housings. An 800-amp rating can be furnished in copper. Westinghouse Electric Corp.

13—TEMPERATURE REGULATOR closes to prevent overheating

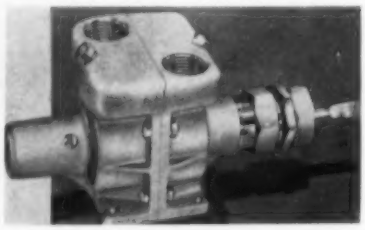
No. 997 is announced as a safety-type temperature regulator that closes automatically to prevent overheating and possible damage to products in process, in the event the thermostatic unit is accidentally damaged. This regulator contains a large (4⅝ in.) bellows for more powerful response and smoother modulating action in controlling the flow of steam, hot water or other medium. Because it has a tight-closing single-seated valve, the No. 997 is declared suitable for "dead end" or terminal service. It is available in sizes from ¼ to 2 in.

Manufacturer recommends this regulator for temperature control of industrial processes, storage or instantaneous water heaters. Equipped with reverse-acting valves, the regulator is applicable for flow control of cooling water to transformers, internal combustion engines, air compressors, degreasers and similar equipment. Fulton-Sylphon Div., Robertshaw-Fulton Controls Co.

14—PUMP PACKING is self forming, chemical resistant

No. 403 Plastic Teflon Packing is described as a self-forming packing suited for emergency use against industrial acids, alkalies, and solvents. This packing is composed of shredded Teflon combined with suitable binders and lubricants extruded in an open cotton yarn jacket impregnated with graphite. The jacket holds the material for ease of installation. It is also available in bulk form, 403S, for packing multi-size fittings and applications where need for rapid assembly prohibits use of a braided or extruded type material.

In cases where pure Teflon has been unsatisfactory because of cold flow, lack of resiliency, or compressibility, 403 has shown excellent results, says manufacturer. It is designed for service from — 150 to 500 F and for all applications (dynamic or static) requiring its chemical resistance qualities. This packing comes in ¼- to ¾-in. sizes on 10-ft and larger spools. The bulk form is furnished in cans. Abbott and Biddle.



15—ROTARY PUMP injects hydrazine in make-up water

According to manufacturer, this molybdenum-free stainless steel pump is designed specifically for the injection of hydrazine into make-up water for boiler feed treatment. Teflon impellers and bearings are standard equipment. A choice of stuffing box assemblies includes plastic Teflon packing or a fluid Teflon stuffing box seal, both of which are designed to prevent air ingress into the pump. This low-capacity, positive displacement pump, with its two axially opposed oscillating impellers, produces a linear, non-surging flow, it is noted. Capacities are to 10 gpm, pressures to 75 psi. Higher pressures are obtained by multi-staging. Pumps are available in conventional mountings, and with electric motor, air motor, pulley and chain drives. Eco Engineering Co.

16—ELECTRONIC SYSTEM brings automation to precipitators

For electrostatic or electrically powered precipitation equipment, this automation system is designed to eliminate manual and visual electrical controls, replacing them by continuously acting feedback servo-circuits. The precipitator is placed in operation by a single start-stop switch for all rectifiers. These electronic circuits, one for each individual electrical set, act to continuously maintain rectifier power output at optimum level for best precipitator performance. Precipitators should be operated at highest possible voltages and power inputs, which in general are limited by sparkover between precipitator elec-

the BIG name in water conditioning is

W. H. & L. D. BETZ, Philadelphia, Pa.

trodes, it is explained — in many cases 50 to 100 sparks per minute. Operation under these conditions requires circuits designed for rapid recovery of precipitator voltage following sparkover.

This control system functions by continuously monitoring and readjusting spark rate to maintain optimum voltage and power input. These vary with changing precipitator conditions — temperature, flow rate, gas being treated and particles being removed. Heart of the system, the control assembly serves to adjust and maintain high voltage output of each rectifier at a preset point of optimum performance. This is done by a continuously operating feedback loop that compares actual current, voltage and sparking conditions in the precipitator with ideal, preset reference levels. Only moving parts in the system are relays that function on startup and shutdown. Units are compact and self-contained, and can be installed on or near precipitator. They are made up of sub-assemblies. Research-Cottrell, Inc.

17—HIGH VOLTAGE starter features compactness

Type ZHA is a high voltage starter (2200–4800 v) only 30 in. deep. Accessible from the front, it may be mounted directly against a wall, or in double rows, back to back. This starter is self-contained, complete with control transformer supplying low voltage for push-button circuits. When starters are ganged, only one incoming feeder is required. Additional starters can be added as needed, with no sacrifice in streamlined appearance. The Type ZHA is also available with self-contained bus in an isolated compartment. It is furnished in three interrupting ratings for squirrel cage, synchronous and wound-rotor motors. Bulletin 8130-F gives full details on the starter. Electric Controller & Mfg. Co., Div., Square D Co.

19—SIGHT FLOW INDICATOR shows up leakage flows

Combining a header and company's Demi Toggle Valve, this assembly is used to indicate leakage flows, or any flow which is small and requires constant checking. Since the valve toggles shut in one plane, open or closed position is indicated by a colored ball. A variation of design is used on purge systems, with a 200-to-1 rangeability needle valve being used for throttling. Flow range available is 0-2 standard cubic feet per hour. George W. Dahl Co.

20—CENTRIFUGAL PUMP saves both space and expense

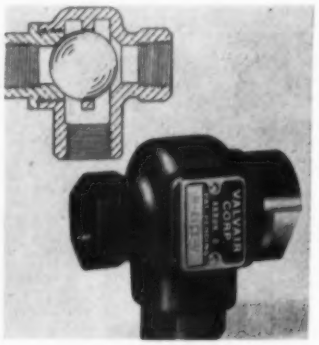
For pump users who want to conserve on both space and investment, this company offers a line of standard, close coupled, centrifugal pumps designed to handle a wide range of general applications where conditions do not necessarily require a more costly "engineered" pump. Identified as Type GSC, the line comprises seven pumps with capacity up to 600 gpm, total dynamic head to 275 ft. Temperature range of pumpable liquids is −40 to 250 F. The line is available in: bronze fitted, all iron, and all bronze. Standard construction includes a removable back head to permit removal of impeller without disturbing piping; large cradle opening for free access to the stuffing box; and a stuffing box which is adaptable, interchangeably, to packing and mechanical seal. Dean Brothers Pumps Inc.

21—COUNTER for pneumatic transmission systems

This remote integrating counter for use with pneumatic transmission systems is a 7-digit unit which receives its signal from a measuring transmitter operating on an impulse duration system. Since the electric signal transmitted is a function of time, line voltage variations are said not to affect the accuracy of the counter. The counter is housed in a small flush mounting case for use near a pneumatic recording or indicating receiver on a panel board, or in whatever location its use would prove most valuable. Bulletin A128 gives additional details. The Bristol Co.

22—DIRECTIONAL VALVE has instant switch-over

This directional valve is designed to afford instant switch-over from automatic to manual control of diaphragm-operated valves, cylinders and similar devices. Installed as a tee in the inlet lines, the valve permits manual take-over



from automatic control, or control from two different sources, when desired, it is stated. It can also be used to prevent inter-mixing of supply when two gases or liquids are being delivered alternately to a tank or container. Automatic in operation, this directional valve can be substituted for a dual top valve, manufacturer says.

The valve is simple in design, consisting of a captive Hycar ball which shuttles between two seats in the bronze valve body. When pressure is applied to one port, the ball shifts to, and seals, the opposite port. For use with air, oil, water or media compatible with Hycar and bronze, this valve is available with ¼ and ⅜ NPT ports. Valvair Corp.

18—OIL-TIGHT PUSHBUTTONS offered in two new types

The Roto-Push is announced as an operator unit combining functions of a single button station with advantages of a two- or three-position selector switch. Contacts are maintained or momentarily operated by turning the guard ring, depressing the button, or a combination of both. Another type pushbutton is the Pres-Test, an indicating light designed to provide a simple means of checking indicating lights without disturbing the control circuit and without removing a lens or bulb.

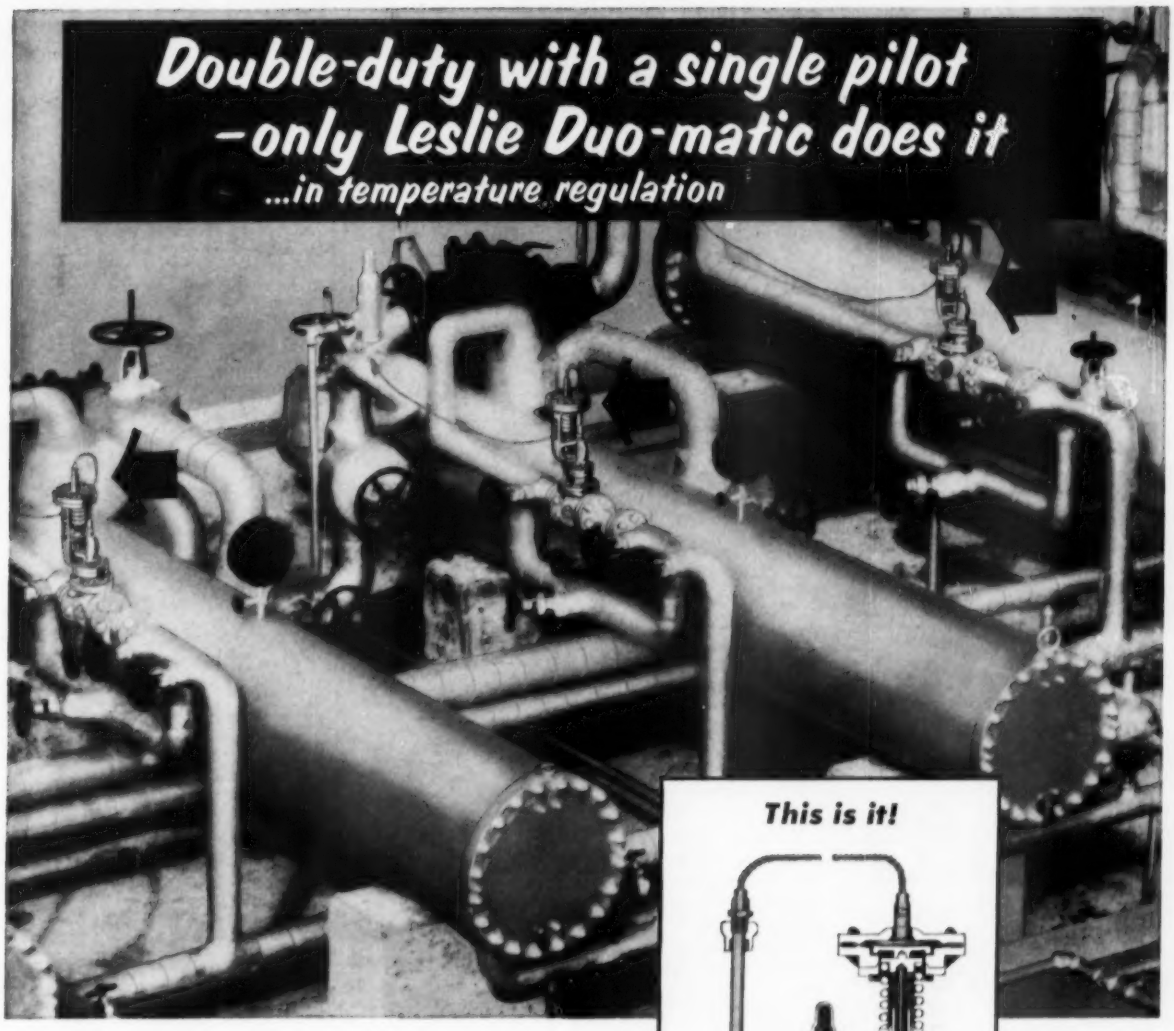
This line of pushbuttons offers a back-of-panel depth of only $1\frac{23}{32}$ in. for transformer types, $1\frac{7}{8}$ in. for resistor units. They come in key-operated, selector switch, flush button, mushroom head or knob-operated models, each utilizing a Neoprene-diaphragm seal. Contact blocks are divided into two isolated compartments with individually operating plungers and circuits which can be both normally open, both normally closed, or one normally open and one normally closed. Three of these blocks can be so arranged as to provide almost unlimited circuit flexibility. Publication EL-178 provides data. Cutler-Hammer, Inc.

23—PRIME COATING protects against rust

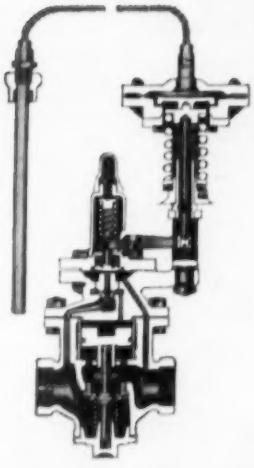
Reported several times stronger than red lead primers, Zinktron is a zinc based paint that gives chemical as well as mechanical protection. According to manufacturer, this is accomplished by having the binding material so fine that the majority of zinc particles are in direct contact with the metal surface it is applied to, the difference in potential of the two metals giving the added protection. Zinktron requires only stirring, and is applied with brush or spray to new iron or steel surfaces or to old, rusted metal. On the latter, the loose rust is first removed and two coats of Zinktron are applied. Rust creep is claimed to be prevented by the double

Double-duty with a single pilot —only Leslie Duo-matic does it

...in temperature regulation



This is it!



Leslie Class LTCO Duo-matic temperature and pressure regulator

The Duo-matic Leslie temperature regulator for controlling steam flow is a single unit, with a *single* internal pilot valve—yet it controls automatically both temperature and pressure conditions. No hunting or cycling on low flows . . . eliminates temperature "droop" on heavy loads.

Simplified piping and better control of fuel oil heaters, instantaneous and storage type heaters, driers, process heaters, kettles, open tanks, ovens, degreasing machines, steam tables, sterilizers, etc., more than offset the initial cost of this superior regulator.

Investigate "dual-function" Duo-matic regulators — proven in service for over 19 years of applications.

Write for Bulletin 5307

TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

LESLIE CO., 301 GRANT AVENUE, LYNDHURST, NEW JERSEY

For more data circle 531 on Post Card

Here's POWER to clean tubes from 1/2" to 2" QUICKLY

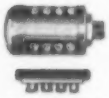
Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

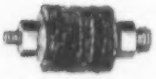
Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

Expanding scraper and replaceable element.



Expanding brush and replaceable element.



Sectional wire brush.

Air valve for one-man operation.

ROTOJET®

Junior TUBE CLEANERS

ELLIOTT COMPANY - ROTO DIVISION

Tube Cleaner Specialists Since 1910

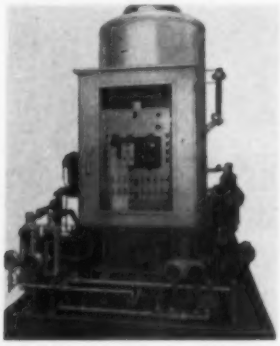
147 Sussex Avenue, Newark, N. J.

For more data circle 532 on Post Card

action protection of this coating — the top decorative coating holds without blistering. Any oil based paint may be used over Zinktron, but it is smooth enough to serve as a finishing coat. It is grey in color. Constad Laboratories.

24—ION EXCHANGER is packaged, mixed-bed unit

Illco-Way Packaged IonXchangers are fully-automatic units, shipped assembled, with gravels and resins in place, ready for connecting and operating. Manufacturer points out that the mixed-



bed principle of ion exchange provides water that is free of silica and ionizable solids with high purity readings. These ion exchangers are available in sizes suitable for most low make-up power plants. The unit consists of a regular mixed-bed column or tank, with associated external and internal piping, mounted on a heavy welded steel base. Automatic operation is provided by motor valves, controlled by a conductivity meter and program timer to govern regeneration. Vessels and piping for refrigerants are also included. Illinois Water Treatment Co.

25—HOSE END is versatile, clamp-type unit

This clamp-type hose end provides maximum versatility in high pressure lines for air, hydraulic fluids and steam,

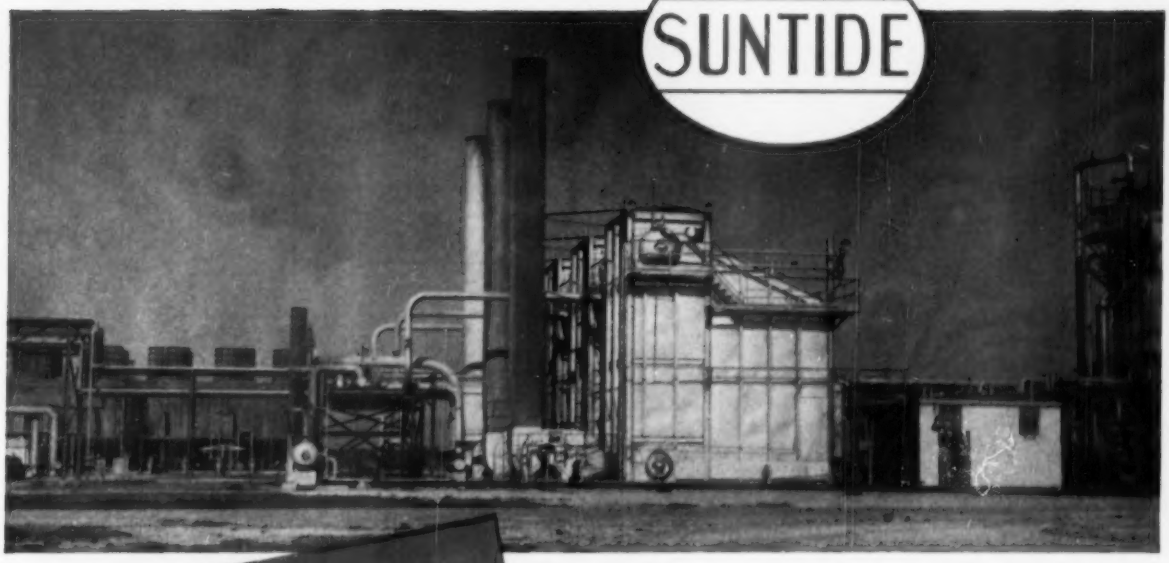
it is announced, and it couples readily on other types of hose. No hose skiving or special tools are needed to install it, company points out, and it may be used repeatedly. Of malleable iron, this hose end is designed to assure free flow and a positive, long-lasting seal. Eight sizes range $\frac{1}{4}$ to 2 in. The Weatherhead Co.

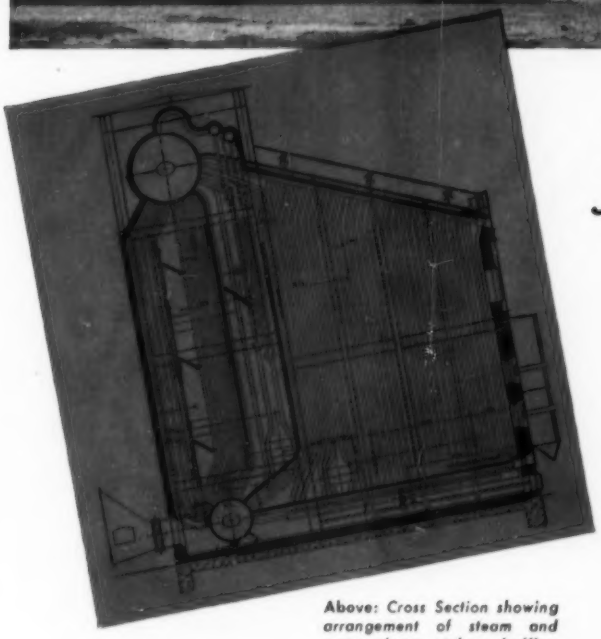
26—VERTICAL BREAK SWITCHES in higher voltage ratings

Both 600- and 1200-amp ratings are available in these new 115-kv vertical break switches for outdoor, group-operation in horizontal, vertical, or inverted mounting position. Designated Type PV2, these switches are suggested for

Vogt STEAM GENERATORS

at **SUNTIDE REFINING COMPANY**
Viola, Texas





Above: *Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.*

3 Units Installed
2 Units on Order

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BPE

OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings and Flanges—
Petroleum Refinery and Chemical Plant Equipment
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HENRY VOGT MACHINE CO.
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SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

For more data circle 533 on Post Card

pd offers 5 basic boiler components

P-D makes it easier, safer and quicker when you sign that order for steam generating auxiliary equipment. There's no time delay; no engineering problems; no piece-by-piece delivery from different sources.

Prat-Daniel's *single responsibility* guarantees equipment of balanced design . . . matched for ease of assembly, unmatched for peak performance. Each component is built to complement the other, with the integrated unit providing highest efficiency for your system.

Prat-Daniel offers years of specialized experience in the design and development of *Forced Draft Fans, Air Preheaters, Tubular Dust Collectors, Induced Draft Fans* and *Fan Stacks* for industry.

Contact The Thermix Corporation, Project Engineers for Prat-Daniel, for your requirements. Ask for data sheets on P-D equipment.

Project Engineers
THE THERMIX CORPORATION
GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

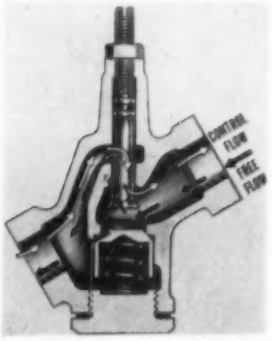
Designers and Manufacturers
PRAT-DANIEL CORPORATION
SOUTH NORWALK, CONN.
POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

For more data circle 534 on Post Card

sectionalizing, disconnecting, and bypassing applications. Ease of operation and positive action under adverse conditions are reported for the switches, and they are designed to meet pertinent NEMA specifications. Rugged simplicity and powerful blade action characterize the PV2 design, it is pointed out. Other features announced include permanent lubrication, high pressure contacts, and flexible interphase mechanism. Line Material Co.

27—SPEED CONTROL VALVE with screw driver slot

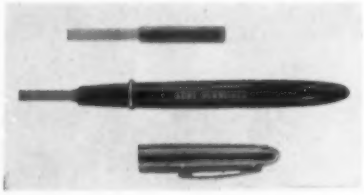
This speed control valve is designed to provide split-second timing of piston movement by positive control of air flow. It can be mounted in any position,



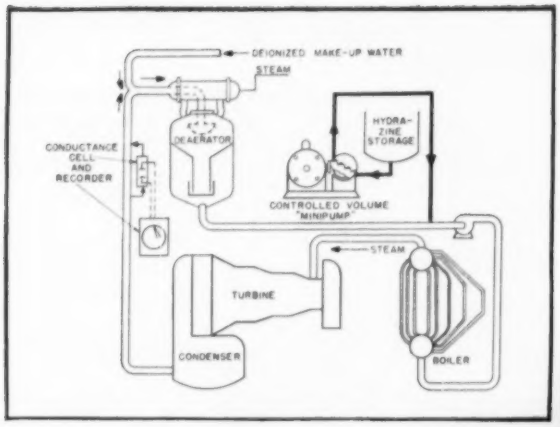
at either or both ends of a cylinder to provide air flow adjustment. Manufacturer says it can be disassembled easily without breaking line connection, and its construction is simple because the only moving part is the poppet. The valve features a screw driver slot, but it is also available with regular knob adjustment or with pin lever adjustment. Ross Operating Valve Co.

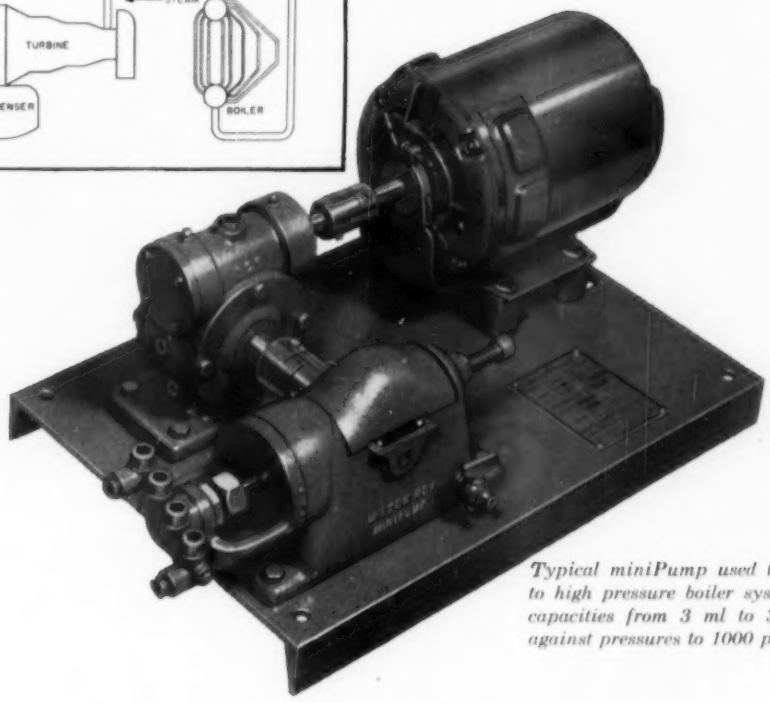
28—CONTACT BURNISHER with a longer basic element

The No. 162 3-in. Contact Burnisher with a slim-grip handle, for use where relay contacts are almost completely hidden and hard to reach, is announced as an accessory for company's pen-type



contact burnisher. Other improvements include a longer basic element in burnisher itself, which provides greater polishing area and greater accessibility, and a spare 1½ in. blade which fits into original case. Further improvements have been made in producing burnisher elements which give a micro-fine polish without pitting or scratching, it is noted. Under this method a series of knife-like edges are produced to polish contacts smoothly. Residual oil film, carbonaceaous deposits, grit, dirt and contact filling are claimed to be eliminated. The pen-type case, made of an insulating plastic, is designed to permit use on energized contacts without danger of





Typical miniPump used to meter Hydrazine to high pressure boiler systems. Available for capacities from 3 ml to 3200 ml per hour, against pressures to 1000 psi.

Controlled Volume miniPump® accurately meters Hydrazine to treat boiler feed water

Residual oxygen in boiler feed water causes pitting and corrosion of pumps, economizers and steam lines. Add Hydrazine to the water, and this corrosive oxygen is removed. But it's not quite that simple. Too much Hydrazine liberates ammonia which will corrode admiralty metal tubes in condensers and heat exchangers. Effective feeding of Hydrazine in small quantities (.005-.030 ppm) calls for the accuracy of a Controlled Volume miniPump.

The pump, as illustrated in the flow diagram, meters from 0-225 milliliters of 3% Hydrazine solution in this 500,000-pounds-per-hour steam generating system. The pump controls the feeding of the additive from startup through running conditions. Capacity is adjustable from 0 to 100% of maximum by adjustment of plunger stroke length.

This is but one example of how Controlled Volume Pumps are rewardingly applied to water treating and other chemical metering jobs. Whatever your own requirements, check first with Milton Roy.

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shock. The handle of this device is also made of an insulating material. The Adre Co.

29—IMPACT ATTACHMENT speeds masonry hole drilling

Pneumatic impact action for high-speed drilling in concrete, brick and masonry can be obtained with any ¼-in. electric drill by means of this rotary impact attachment, it is announced. Called Hammerin' Hank, the attachment is 6 in. long, 1½ in. diam. It is claimed able to drill ½-in. holes, 3 in. deep in concrete within 30 sec. It uses a 25-lb

pre-loaded spring and two rotating cams to provide two blows per revolution. Manufacturer says it develops about 90,000 ft-lb impact force.

The unit is suggested for use in electrical and plumbing construction and general maintenance work, due to its power, compactness and light weight (1½ lb.). According to company, high drilling efficiency can be obtained with 15-lb pressure, which makes the unit adaptable for close-quarter work and on ladders where it is difficult to apply greater pressure. Hammerin' Hank can be chucked into any standard carbide drill, including ¼- to ⅞-in. sizes. The standard collet takes a ½-in. drill shank, and sleeve bushings are provided to take ¼- and ⅜-in. shank diameters. This attachment will sell for approximately $16.00, according to the manufacturer. Power Tools Corp.

30—LUG-TYPE CONNECTOR for economical terminating

Ka-Lugs are announced as lug-type connectors for economical terminating at service switches, terminal blocks, or other locations where space and cost are factors. Connectors are available for copper conductors from No. 14 through 500 Mcm. Easy installation and electrical dependability as well as low first cost are stressed by the manufacturer. Smaller Ka-Lugs are forged and larger sizes are cast of high-strength, high-conductivity copper, with a plated steel socket screw for maximum compression. Compact design facilitates installation in limited space. A screwdriver installs smaller Ka-Lugs, an Allen wrench installs the larger sizes. Hex body is easy to hold during tightening, company points out, and because each Ka-Lug takes a range of conductors, only five lug sizes are required to accommodate all conductor sizes. The Burndy Corp.

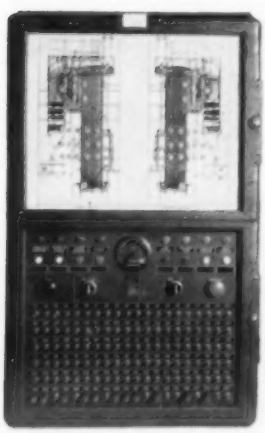
Another Vulcan Selective-Sequence for Consolidated Edison!

Con-Edison specifies Vulcan Selective-Sequence Soot Blowing for Arthur Kill Station

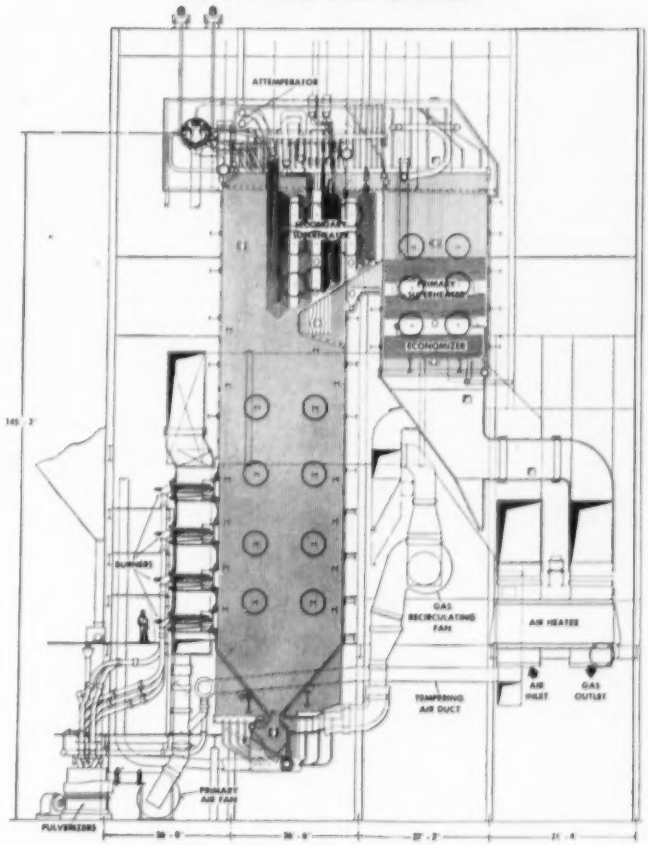
The 2,400,000 pph boiler planned for the Arthur Kill Station, Staten Island, is an exact duplicate of the boiler at Astoria Station. As at Astoria, each of the two forty-foot furnaces will be equipped with an all-electric custom designed Vulcan system.

Drive for the soot blower systems will be electric; the blowing medium steam. Each wall deslagger and long retractable soot blower has a direct-acting Type D head, and a pressurized seal and aspirator for the pressurized furnace. Wall boxes for the long retracts combine scraper and seal. This novel arrangement simplifies sealing off boiler gases from the soot blowers, and assures full protection.

Whether your boiler is large or small, power or process—a modern Vulcan Soot Blower System with automatic-sequential or selective-sequence control will keep it operating at peak efficiency. Your Copes-Vulcan representative has the ideas, information and experience to help you choose the system best suited to your needs.



NERVE CENTER of the Selective-Sequence system consists of two completely pre-wired, factory-assembled controllers—one for the soot blowers in each furnace. Selective-Sequence lets operating personnel select the proper blowing sequence for most effective boiler cleaning. Since each soot blower is separately monitored, the operator can tell at a glance which blowers are operating, time elapsed, number of blowers that have operated and the location of any malfunction of equipment or blowing medium.



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2—40'-0" FURNACES

Capacity, Lb. Steam per Hour	2,400,000	High-Pressure Steam Temperature, F	1,050
Design Pressure, PSI	2,500	Pressurized Furnace	
Fuel	pulverized coal, oil or gas	Reheat Steam Temperature, F	1,000
Superheater Outlet Pressure, PSI	2,150		

C-3400A

COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA

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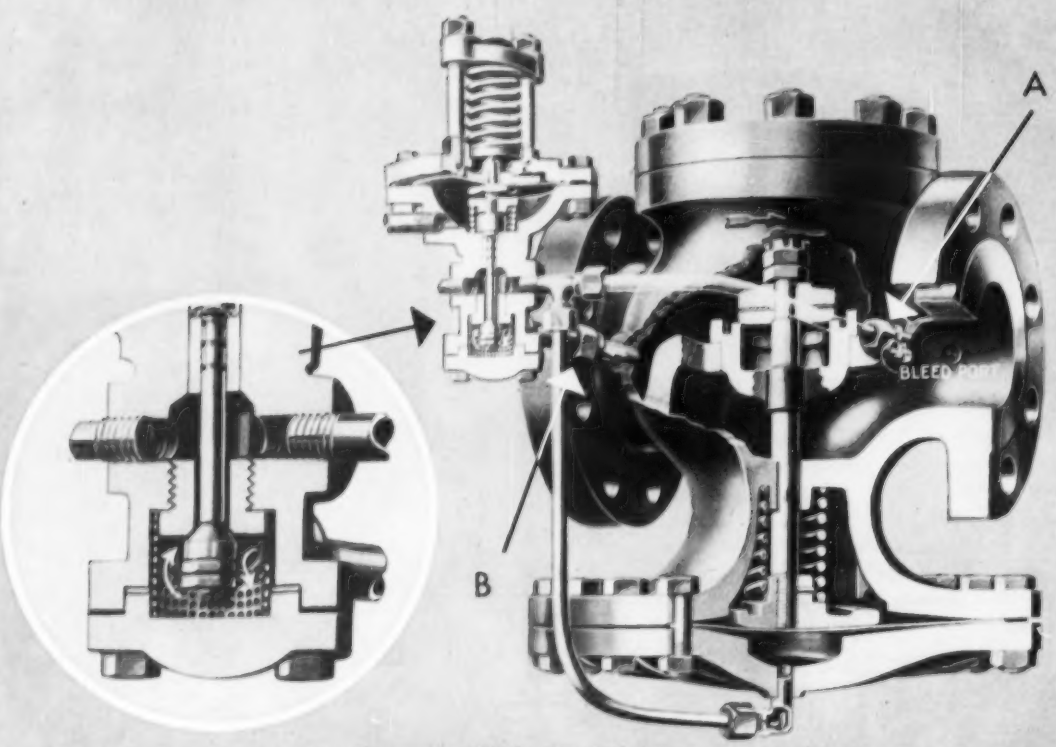
VALVE TIPS:

Advantages of External Pilots in Automatic Regulating Valves



Spence Type ED Pressure Regulator

"Maintenance-free, trouble-free, install-and-forget." They're all pretty phrases, but every engineer knows from experience they don't apply to regulating valves. Any valve designed to control temperatures or pressures within tight limits can be affected by dirt or other foreign matter in steam lines.

One advantage of the external pilot mounting shown above is simplified maintenance. Trouble shooting is faster, downtime is reduced, and tempers don't take such a beating. Here's why:

If trouble develops, it's easy to find out if it's in the pilot or the main valve. Just remove the tubing bend at A. A simple test, without any instruments or other equipment, shows where the trouble is.

If the trouble is in the pilot, you can remove it by disconnecting the unions at B. There's no need to take the main valve out of the line.

The quickest way to get the regulator functioning again is to install a spare pilot. This is easy — and in the Spence design it's not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves. There's no need to stock an expensive inventory of pilots for each main valve size.

In the enlarged sectional drawing above, you can see how the strainer, seat and disc of the pilot are readily accessible by removing the blind flange.

If the trouble is in the main valve, here again inspection is easy. If there's dirt in the steam line, it may clog the bleed port or restriction orifices. In the Spence design these can be inspected and cleaned by merely removing the tubing connections. The seat and disc of the main valve can also be inspected easily by removing the top flange.

These maintenance advantages, plus other advanced design features, are available for a wide range of regulating applications. For information on Spence's wide range of different automatic regulating valves, write for your copy of Bulletin 1005.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

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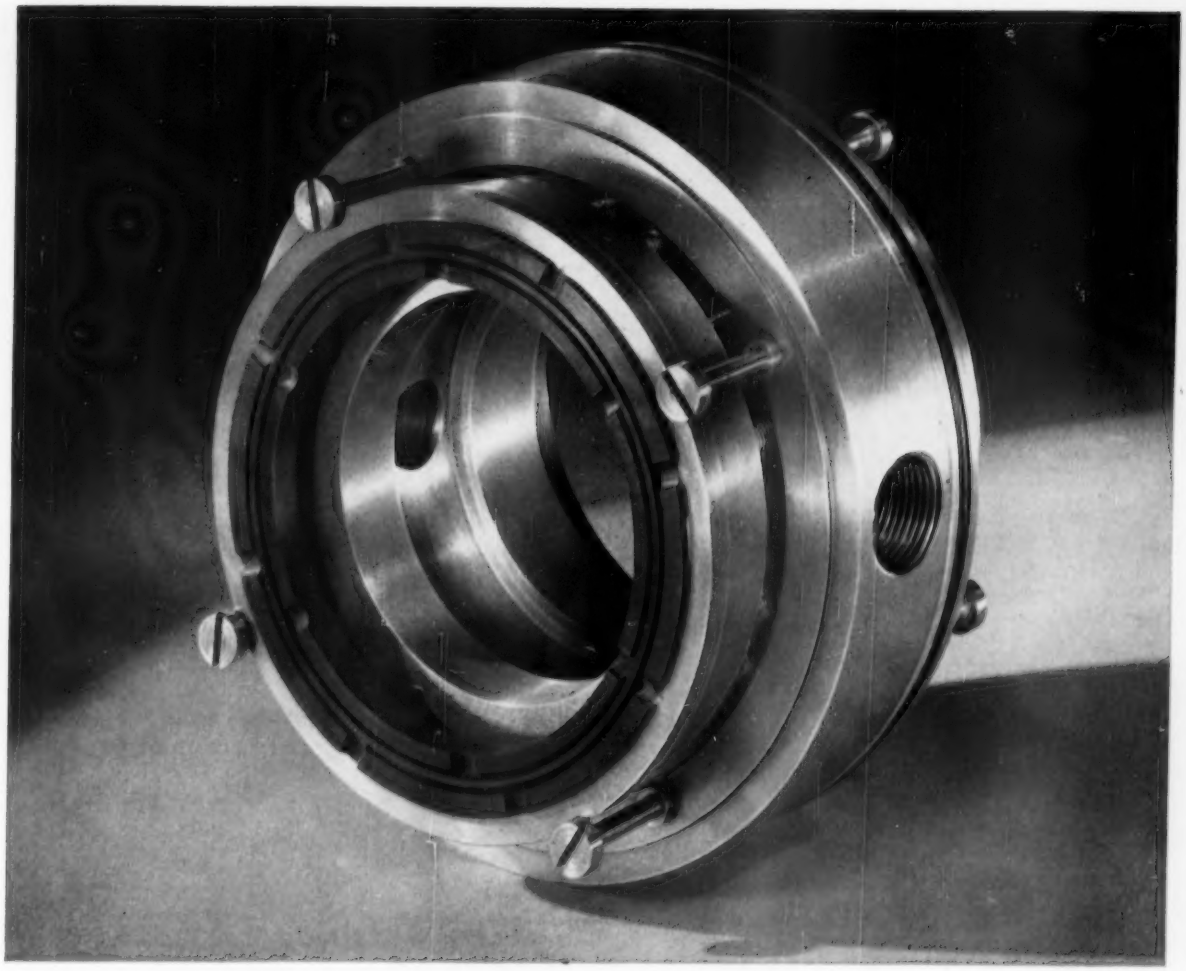

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If you have a sealing or piston ring problem, Koppers entire research, production and engineering facilities are at your disposal. For more details, write to the KOPPERS COMPANY, INC., 7403 Hamburg St., Baltimore 3, Maryland.

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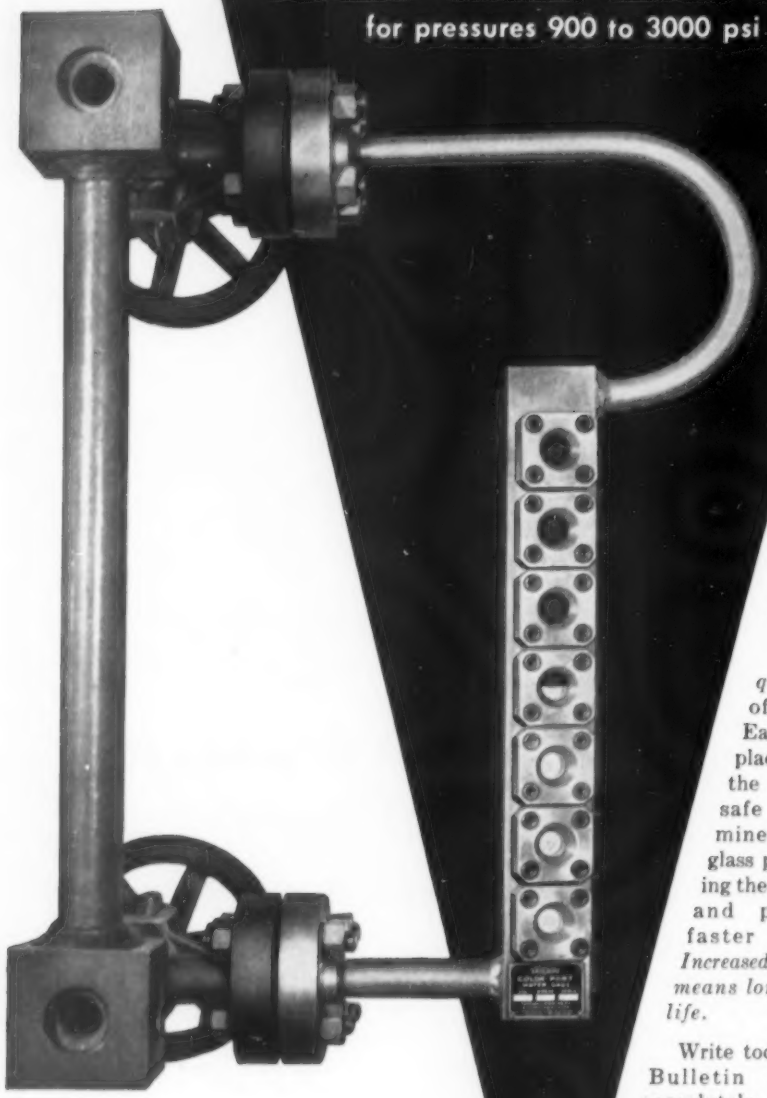
for pressures 900 to 3000 psi



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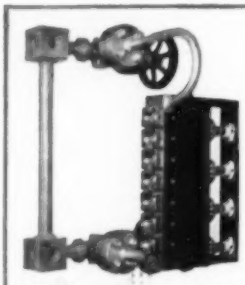
- *reduced maintenance!*
- *increased availability!*

Now Yarway offers brilliant two-color boiler water level readings, combined with simplicity of gage maintenance and increased availability.

With the new Yarway Color-Port Gage, water space shows green, steam space shows red. A full gage is all green and an empty gage all red.

The Color-Port Gage is *serviced quickly in place* by simple replacement of individual cover-glass assemblies. Each cover assembly is held solidly in place by four socket head capscrews and the "floating assembly" design applies safe predetermined loads on glass ports, reducing thermal shocks, and permitting faster warm-up. *Increased availability means longer service life.*



Side view of Yarway Color-Port Water Level Gage with illuminator, circulating tie-bar and Welbond gage valves.

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YARWAY WATER LEVEL GAGES

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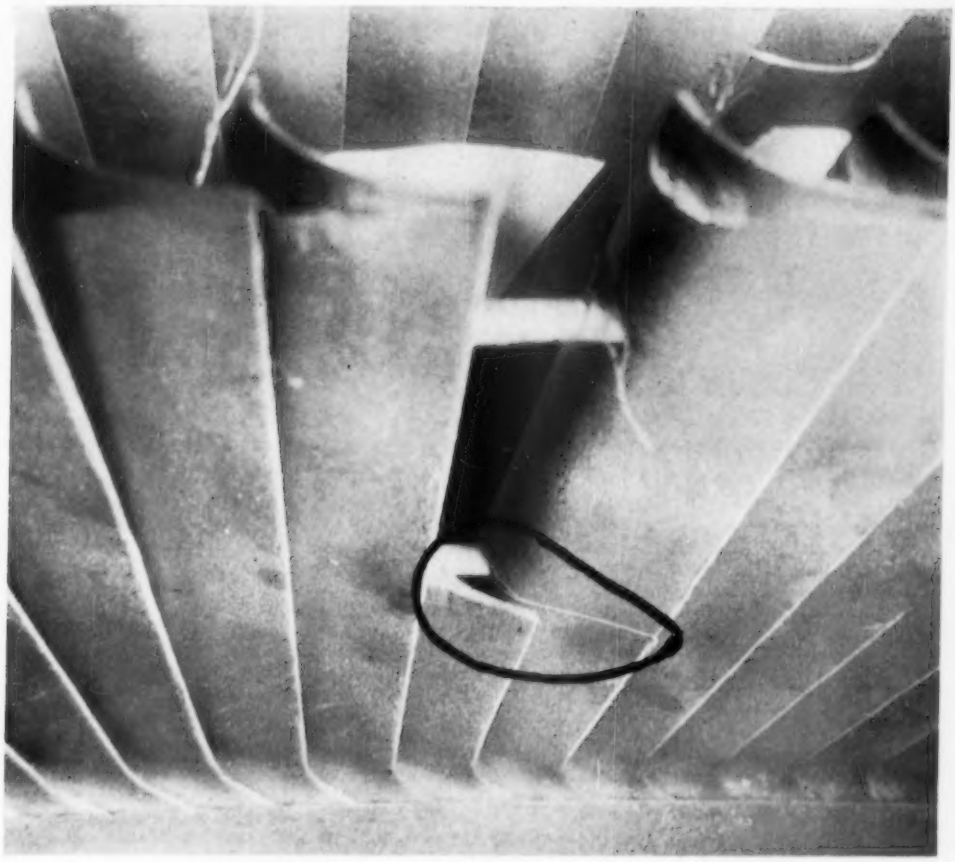

Fig. 1. Magnetic particle testing shows up crack through lashing wire hole of turbine blade next to broken blade. Method of using test explained in text

How Non-Destructive Testing Aids Power Station Maintenance

To cut severity of mechanical failures, hold forced outages of costly equipment to minimum, Con Edison uses non-destructive testing as important part of preventive maintenance program. Among them are tests using plain and fluorescent magnetic particles, fluorescent and dye penetrants, ultrasonic vibrations, and gamma radiation

By JOSEPH L. McPARLAN *

UNLIKE MANUFACTURING processes in which a part may be tested and discarded during any stage of its fabrication, the complicated mechanical assemblies on which central station maintenance is performed do not lend themselves to easy inspection of individual components. Failures of internal parts of high-speed steam turbines, pumps, reduction gears and so on, may have disastrous consequences.

Any policy of preventive maintenance, then, embraces a knowledge of the possibilities and limitations of the available methods of testing metals and machine parts non-destructively. The following will outline some of the methods used by the writer's company, among which are tests employing plain magnetic particles, fluorescent magnetic particles, fluorescent penetrants, dye penetrants, ultrasonic vibrations and gamma radiation.

Test Handling Gear First

Because of system load demands, schedules for general overhaul of main turbine generators must be planned months ahead of the actual outages. Immediately before removal of a unit from service for major maintenance, all crane hooks, lifting lugs, trunnions, heavy shackles, turnbuckles, and other handling apparatus which will be used during the work, are inspected for defects both visually and by the magnetic particle method.

Great importance is attached to this procedure, because parts weighing well over a hundred tons may have to be transported over other operating turbine-generators. Defects in lifting gear requiring repair or replacement have been detected by these tests.

After a turbine has been dismantled, the condition of the spindle and its thousands of buckets is of primary concern. Since these buckets may be

* Superintendent, Mechanical Construction Bureau, Consolidated Edison Company of New York, Inc.

Fig. 2. Crack in turbine shaft fillet is clearly shown by a magnetic particle inspection; otherwise might be hard to see

Fig. 3. Magnetic particle test shows series of short cracks in fillet of a turbine shaft; these might lead to failure

highly stressed due to the combination of centrifugal, torsional, bending and vibrational forces, all coupled with high temperatures, they are particularly susceptible to fatigue failure. Rupture of a single blade may trigger a progressive failure throughout the following rows of blades.

Magnetic Particle Testing

If visual inspection does not disclose any serious defects, the spindle is cleaned thoroughly by either wet or dry blasting for more minute inspection, care being taken to avoid pitting the surfaces during this operation. All magnetic parts of the spindle body, buckets, shrouding, lashing wires, journals, and so on, are then examined carefully by the magnetic particle method. This method is particularly advantageous for this application because most of the defects develop in service and originate at a surface where the magnetic powder readily delineates a disturbance of the magnetic flux at discontinuities in the magnetized part.

Shallow cracks that do not impair the serviceability of a part may be ground out. It is advisable to finish off a grinding repair by blending the adjacent metal to avoid stress concentrations at abrupt changes of section.

Serious cracks in turbine blades may entail removal of defective blades or, if a general pattern of fatigue type failures becomes evident in a row, the entire row may have to be removed. The latter eventuality may prove embarrassing, inasmuch as rows of turbine buckets are not stock items and procurement may be a matter of months. For this reason, case histories of turbine blading defects are recorded, in an effort to forestall delays due to unavailability of replacement parts.

Figure 1 shows a broken spindle blade and, alongside, another blade with a crack through a lashing wire hole clearly outlined by the magnetic powder.

Fluorescent Magnetic Particle

Since ordinary magnetic particle testing is fatiguing on the operator because of the lack of contrast between powder and background, the use of fluorescent magnetic particles offers some beneficial aspects. For example, the underside of blading shrouds and lashing wires and sides of closely spaced disks are difficult to observe directly, and faint indications may be overlooked. A trace of coated magnetic particles glowing under a beam of "black" light is more readily noticeable than a build-up of powder.

An objection to this method arises in that the powder must be dispersed in oil for easy application by spraying or brushing on the surface. A turbine spindle coated with oil must be washed before re-assembly to avoid feedwater contamination and coating of condenser tubes.

Figure 2 shows a crack extending around the shaft fillet of a turbine spindle. The gray magnetic powder deposit indicates clearly the direction and extent of the crack. The section of the shaft adjacent to the seals is especially susceptible to the development of cracks of the type shown in Fig. 3.

In some cases, short individual cracks have joined to form continuous circumferential cracks of considerable

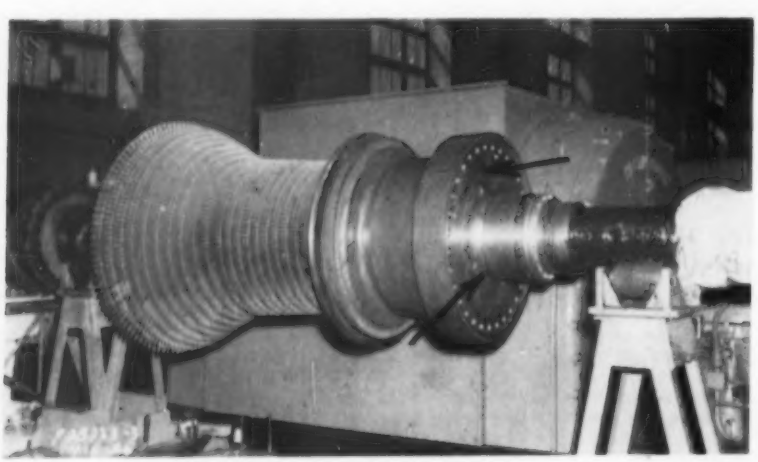

Fig. 4A. Completed machine work done on turbine spindle to remove cracks found in fillets and face of the dummy piston by magnetic particle tests. See Fig. 4B

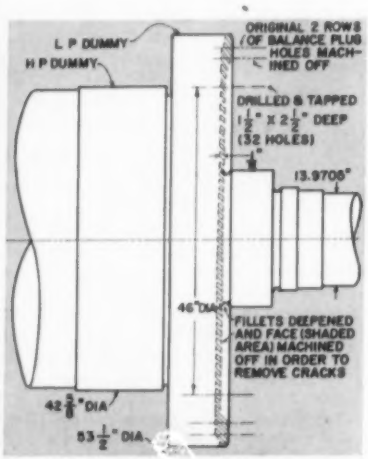
L P DUMMY
H P DUMMY
ORIGINAL 2 ROWS OF BALANCE PLUG HOLES MACHINED OFF
DRILLED & TAPPED 1½" X 2½" DEEP (32 HOLES)
13.9706"
46" DIA
FILLETS DEEPENED AND FACE (SHADED AREA) MACHINED OFF IN ORDER TO REMOVE CRACKS
42⅜" DIA
53½" DIA

Fig. 4B. How fillets and face of dummy piston's body, Fig. 4A, were machined

depth. Removal of such a shaft crack required machining the end face of the spindle and deepening the fillet, as shown in the photograph and sketch of Fig. 4. A defect of this type, if permitted to progress deeply enough to reduce the shaft diameter below an allowable minimum would make it necessary to discard a costly spindle. Repeated discovery of identical defects in similar machines usually leads to corrective modifications of design or of operating procedures.

Thick-walled forgings and castings used in turbine cylinders and stop valves are subjected to extremely severe operating conditions. With inlet steam conditions of, say, 1000 F and 1500 psig, the metals operate at red heat and under some circumstances are called upon to withstand wide temperature differentials between the inner and outer walls of the shell.

Internal Surface Cracks

It is not unusual to find that a valve body contains a number of internal surface cracks. A few of these discontinuities may be visual, but by far the greater number will have to be located by magnetic particle tests. Occasionally a definite pattern of crack distribution and orientation is observed leading to the suspicion that eventual linking-up will occur.

Figure 5 is a photograph of typical indications of cracks by the magnetic particle method in the inner wall of a main turbine stop valve.

Tests on one valve body showed relatively short cracks in both inner and outer walls. The body has a nominal wall thickness of 4 in. and is a chromemoly forging. Exploratory grinding and probing with small drilled holes revealed that the surface cracks were not shallow, but spread deeply through the interior of the wall. It was decided in this case that the condition was sufficiently serious to warrant complete removal of the questionable metal.

As the chipping and grinding progressed, frequent checks were made by the dye-penetrant method.

Fig. 5. Cracks in turbine throttle valve body indicated by magnetic particle test. Note how several holes have been drilled into the crack to determine its depth

Dye Penetrant Test

Method employs a liquid penetrant containing a red coloring substance, which is sprayed on the surface to be tested. It is given a brief time to soak into any surface separations that may be present. The excess penetrant is then removed and a "developer" is sprayed over the surface. Any liquid remaining in a fissure will be drawn, by capillary action, into the pores of the developer.

Figure 6 shows the appearance of the stain along a crack. Essentially this testing technique is a refinement of the venerable oil-and-whiting method.

Dye-penetrant testing is advantageous in that it is readily applied, yields quick results, and does not require a highly-skilled operator or expensive and bulky apparatus. It may be advisable to check final results by the magnetic particle method.

As the probing of the defects in the valve progressed, it became obvious that subsurface conditions were worse than the original surface imperfections had indicated. Thereafter, metal was removed by oxy-acetylene flame-washing instead of by chipping, grinding and drilling. Flame-washing differs from ordinary burning in that the metal removed is not oxidized but is made molten and subsequently washed out by the stream of gas from the torch. When the technique is applied skillfully, the crack remains visible as a dark line contrasting with the glowing background.

However, material along the flame-washed surfaces should be chipped or ground subsequently to a depth sufficient to remove all heat-affected metal. This is done to insure that some degree of structural uniformity will exist after the material has been replaced by welding. As Fig. 7 shows, it was necessary to go completely through the wall before the last vestiges of the crack disappeared.

The cavity was filled in by arc welding. Preheating was applied to the entire valve body by closely regulated induction heating. Each weld bead was stress-relieved mechanically by peening and subsequently tested

Fig. 6. Dye-penetrant testing method reveals cracks in turbine throttle valve body on one of the important units

Fig. 7. Hole made through turbine throttle valve (stop valve) to remove cracks of Fig. 6 revealed by dye-penetrant

Fig. 8. Completed weld in body of turbine throttle (stop valve) to fill hole as in Fig. 7

for internal soundness by the magnetic particle method. Final stress relief of the entire forging was carried out using carefully controlled heating rates and soaking intervals. Figure 8 shows the completed weld.

Radiography

Work just described was considered sufficiently important to justify searching the material in the walls of the valve body for internal soundness by radiography employing gamma radiation from a cobalt-60 source. Use of radiography in station maintenance work is confined to those cases which fall within the requirements of the applicable code, or to the occasional critical repair where more complete information about internal conditions of pressure vessels is sought.

Function of a main steam strainer is to protect the turbine against damage from stray metal, weld rod stubs and so on, which may have been left inadvertently in the steam leads or superheater steam path. These strainers may be cylinders with thousands of small drilled holes, or may be flat grids, and will vary in thickness from ¼ in. to 1 in. Cracks have developed from hole to hole and, as partial disintegration ensued, pieces of the protective strainer have entered the turbine, causing serious damage to the blades.

Fluorescent Penetrant Testing

Periodic inspections are made on strainers by the fluorescent penetrant method. This method is used because the materials usually are non-magnetic. Indications by this method appear as in Fig. 9.

This fluorescent penetrant method is identical in principle and application with the dye-penetrant method previously described, except that the penetrating oil carries a fluorescent addition. The surfaces to which the penetrant and developer have been applied are viewed under "black" light from a portable lamp. Surface discontinuities into which the penetrant has seeped are plainly revealed by the glowing pattern of the mixture. Best results are obtained when inspection is carried out under conditions of subdued general illumination.

Another specific application of the fluorescent penetrant method is inspection of the massive end coil retaining rings of rotating fields of generators. The metal of these rings is only weakly magnetic. Since stress levels may run somewhat on the high side, it is the policy of the writer's company to inspect these rings whenever a field has been removed from a generator.

All the foregoing testing techniques entail extensive disassembly of heavy apparatus to make accessible the part to be examined. Where testing is coincident with disassembly of machinery for mechanical maintenance, testing costs become incremental only and are not objectionable. However, in some instances, where it is desirable to inspect a part for internal or external flaws without incurring excessive dismantling costs, ultrasonic testing may be used to advantage.

Ultrasonic Vibrations

In this method, mechanical vibrations of the order of 10^6 cps are transmitted by the piezo-electric effect through the material of the object under investigation. The resulting action of the vibrations is usually observed by means of an oscilloscope. Any discontinuity interrupts the progress of the impulse through the material and is clearly shown by the wave form on the viewing screen.

The method has been used successfully on centrifugal pump shafts where complete disassembly of casing cover, impellers and shaft sleeves was undesirable, and on the exposed impellers of high-speed blowers. Shafts may be tested longitudinally or transversely depending upon accessibility. An experienced operator is essential for correct interpretation of results since shaft fillets, keyways and other changes of section may yield ambiguous information.

None of the testing methods discussed above replaces any of the others. Necessarily, there is overlapping to some extent, but their very similarity of purpose serves to accentuate the supplementary nature of the several methods. With a full understanding of the particular field of application and of the limitations of these highly developed techniques, non-destructive testing can be of valuable assistance in lessening the severity of mechanical failures and in holding enforced outages of costly equipment to a minimum.

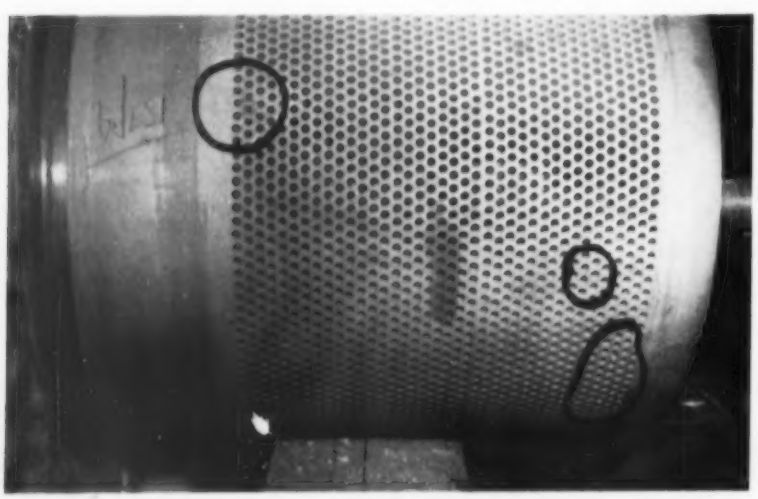

Fig. 9. Indication of cracks in steam strainer of turbine throttle valve as revealed by fluorescent penetrant method. This strainer is a vital equipment unit

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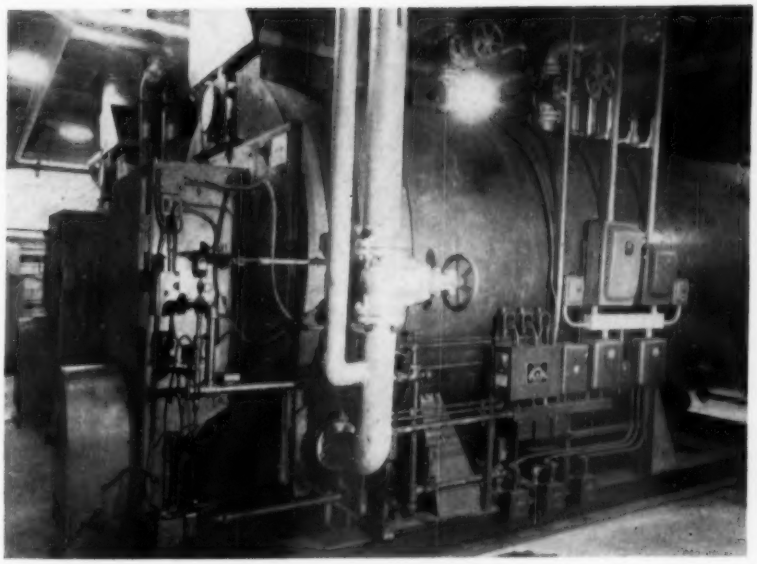


Fig. 1. Two 500-hp modified package-type, firetube Scotch marine boilers, each with 17,000,000 Btu per hr capacity, h-t water at 360 F at 145 psig

H-T Water Heats Reaction Motors

System made savings by reducing pipe sizes, number of valves and accessories at Reaction Motors, Inc plant, Denville, New Jersey. One of first U. S. industrial installations of such h-t water systems

By **PAUL L. GEIRINGER** * and **MICHAEL C. GOGATS** †

HIGH-TEMPERATURE water system installed at Reaction Motors, Inc, Denville, New Jersey, is designed to supply heat from a central heating plant to approximately 200,000 sq ft of floor space in four buildings. Drawing heat from this plant are RMI's administration building, the Naval Industrial Reserve Aircraft Plant composed of a research engineering building, an experimental shop, and a plant services building. Heat for a 100,000-gal elevated water tower is also supplied from this central system.

H-T Water Generators

Two Continental high-temperature water generators with a maximum capacity of 17,000,000 Btu per hr each, are installed, Fig. 1, one acting as a standby for the other. They produce water at 360 F and operate at 145 psig. They are oil-burning, fire-tube generators, with space in the top of the boilers used as the expansion chamber in lieu of an exterior expansion drum. The generators may be operated simultaneously, and consequently have a 5-in. steam equalization line connecting the expansion spaces, and also a 5-in. water equalization line connecting the steam and water spaces, respectively, in the two units. These lines are needed to assure uniform pressure, and water level, in the two boilers in case they are operated simultaneously.

Water is circulated through the boiler, around the distribution system loop, and back into the boiler by a single pump. Two pumps, one a standby for the other, of 400 gpm capacity each and driven by a 15-hp motor, circulate the high temperature water throughout the system. The head and capacity of these pumps can be increased for future load requirements by changing the impeller and motor. The water is taken from the generators by means of a suction line extending below the water lines of the boilers, leaving a steam cushion at the top of the boilers. The water is then pumped to the buildings at an average pressure and temperature of 180 psig and 330 F. The return water is directed back into the generators, except for a certain amount which may be diverted through a bypass to the suction side of the system pumps and mixed with hot water from the boilers, in order to reduce the temperature in the system. This mixing is done when the load is light in order to save fuel. The average return pressure and temperature is 145 psig and 265 F.

Cool return water is injected also into the flow, in small amounts, at the head of the suction line of the generators, in order to eliminate flashing at this critical point by slightly reducing the temperature of the water below the saturation temperature. Boilers are equipped with low-level alarm, and burner shut-off and high-level alarm. The system is equipped with a small boiler water feed pump, a heated feed water tank and a water treatment installation.

Fuel Oil Heating

Fuel oil handling system is designed for No. 6 oil, and consists of two independent circuits: 1, for preheating the fuel oil in the storage tanks; and 2, for heating and pumping oil from the storage tanks to the oil burners.

Preheating is accomplished by means of a forced-circulation low-temperature hot-water system. This equipment consists of a gas-fired hot-water heater, a water circulator, a hot-water expansion tank, and hot-water heating coils, installed in the fuel oil storage tanks. This system is equipped with automatic air vents, and an automatic cold-water filling connection with pressure-reducing valve and pressure relief valve set at approximately 12 psig. Temperature of the hot water leaving the heater is controlled by a thermostat located at the water outlet from the heater. The hot-water circulator, which is mounted at the side of the heater, circulates the water between the heater and the coils in the fuel oil

*Chief Engineer, American Hydrotherm corp, and †Facilities Engineer, Reaction Motors, Inc.

Fig. 2. Plant of Reaction Motors, Inc, approximately 200,000 sq ft of floor area, on 58 acres in Denville, New Jersey

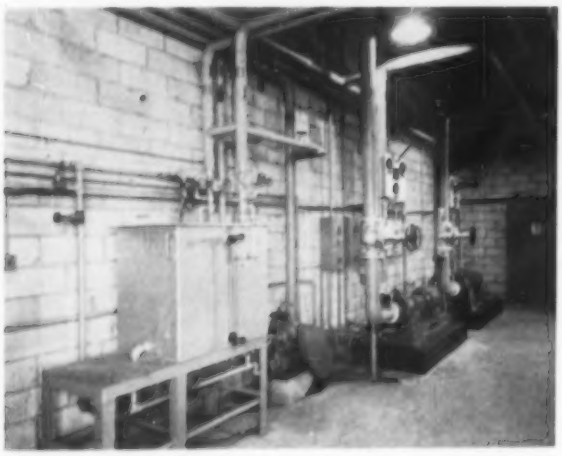


Fig. 3. Two 400-gpm h-t water circulating pumps driven by 15-hp motors, designed for increasing head and capacity by interchanging the impellers and motors when necessary

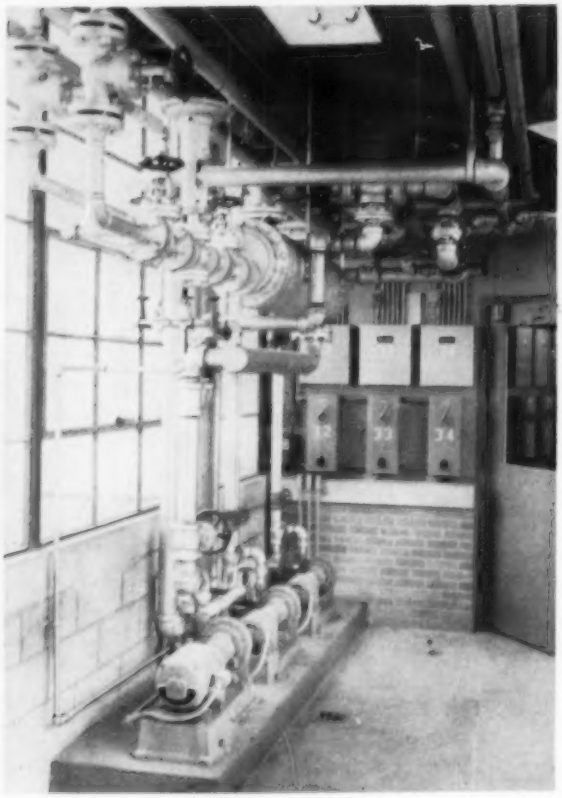


Fig. 4. Converter installation for reducing 360-F h-t water to low temperature of 180 F for peripheral finned-tube radiation. This radiation is to supplement a hot air system

tanks. Operation of the circulator is controlled by an aquastat inserted in the fuel oil suction line inside the boiler room.

Oil Storage

Two underground storage tanks of 10,000-gal capacity each serve to supply fuel oil to the boilers. Preheated oil may be drawn from either tank to a common header supplying two transfer pumps — 600 gph capacity. Each fuel oil transfer pump is wired electrically so that pump No. 1 operates with boiler No. 1, and pump No. 2 operates with boiler No. 2. However, in an emergency, the pumps can be switched over manually to operate with the other boiler.

From the transfer pump the oil goes to a hot water heater, which raises the temperature of the oil to 200 F required for combustion. Hot water for heating the oil is drawn from the high-temperature water supply line, passes through the tubes of the heater and returns to the high-temperature water return line. After leaving the heater, the oil passes through a fuel oil booster pump which raises the pressure to 300 psig, required for proper combustion, and thence to the variable — capacity pressure atomizing nozzles. Burning rate is controlled by a variable port valve in the return line from the nozzles.

Electric oil heaters are installed in the oil lines, and have sufficient capacity to raise the oil temperature to that required for proper combustion, when the boiler plant is shut down and the hot water heater is inoperative.

Recirculating line is provided to allow for circulation of oil through the piping system and back to the oil tank during the off firing periods. This arrangement is fully automatic in operation and maintains oil of proper firing temperature in the system at all times. This system is provided with pressure relief valves, pressure regulating valves, and shut-off valves for proper operation.

Water Distribution System

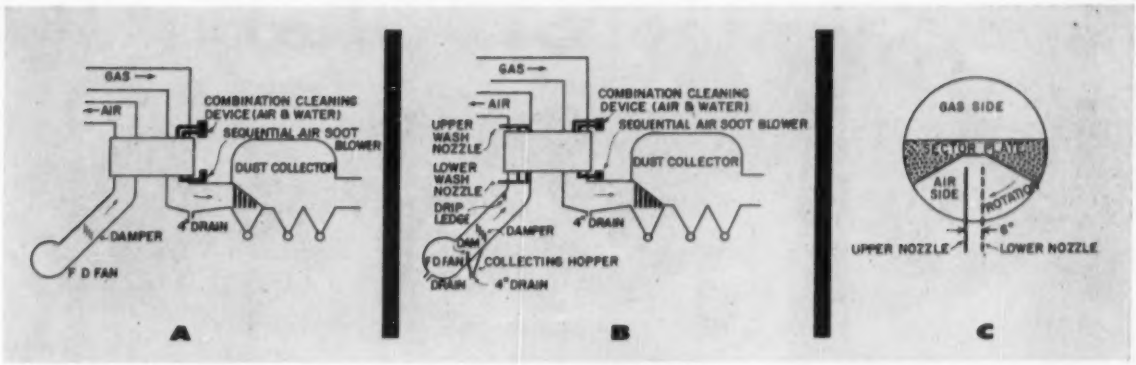
Distribution system consists of approximately 4000 ft of pipe, of which approximately 100 ft is run underground in conduit. The remaining distribution is hung from the ceilings, within the buildings, to save the cost of underground piping, and to provide easy access for maintenance. The system supplies heat to the four buildings through unit heaters, blast type heaters, and fin-tube type radiators. High temperature water is circulated directly through the coils of the unit heaters, and the blast type heaters. Low temperature hot water (210 F) is supplied by a converter for the fin tube radiators.

Savings Made

Advantages of this high-temperature water system, which was substituted for the originally-designed high-pressure steam system, include lower initial installation costs by reducing the main pipe line size from 8 in. to 4 in.; and of supply and return lines to unit heaters from 2 in. supply and 1 in. return, to ½ in. supply and return. In addition, pressure-reducing valves, manholes, sump pits, condensate pits and associated equipment were not required. This has resulted in a considerable saving in maintenance costs.

Savings noted above enabled Reaction Motors, Inc. to substitute finned-type peripheral radiation along the periphery of the buildings to supplement the originally specified hot air system.

Architect for the project was Frank Grad & Son. The general contract was awarded to the Ferber Co and the heating and plumbing contractor was Fred Wendel. The high-temperature water-heating system described here was designed by American Hydrotherm Corp.



Diagrams of air preheater washing practices at St. Clair. A: Arrangement of equipment in out-of-service washing. B: Arrangement of equipment for in-service washing. C: Plan of air preheater rotary element showing relative positions of nozzle

In-Service Washing of Air Preheaters

DETROIT EDISON'S St. Clair Power Plant has experienced difficulty with air-preheater fouling caused by flue-dust deposits on the cold-end surfaces. Removal of these deposits by the conventional out-of-service washing did not prove satisfactory, and as a result, in-service washing has been tried. In ASME Paper 56-A-161, H. J. Hupfer, R. J. Stanley, and A. H. Van Sickle describe the equipment at the St. Clair plant for out-of-service and in-service washing procedures, also the results obtained from 11 in-service washings of air preheaters. They also discuss the known factors responsible for the success or failure of in-service washing. The preheaters are of the Ljungstrom rotary regenerative type.

Diagrams A and B show the arrangements for out-of-service and in-service washing respectively.

1. Washing two air preheaters simultaneously: Time would be saved if both preheaters could be washed simultaneously. This would require balancing of the flows through both forced and induced-draft fans. This was attempted on one occasion, but the higher velocity air in the entering-air duct entrained the wash water falling from the heating elements and carried it back into the air preheater. This caused wetting of the entire cold-end surface resulting in increased carry-over into the gas side.

2. Decreased superheated steam temperature and pressure: During the first in-service washing, the lowest temperature of gas entering the air preheater, obtained by reducing steam pressure and temperature, was 485 F. With normal steam conditions at the same load, the gas temperature was 525 F. Because of the time required and the small reduction in gas temperature, decreasing of steam temperature and pressure was discontinued.

3. Increased rotor speed: On one occasion the air-preheater rotor speed was increased to 1 rpm to shorten the washing time. Water carryover into the dust collector immediately increased, and the rotor was slowed down to ½ rpm to correct the condition.

4. Wash-water temperature: Water temperatures between 60 and 180 F have been tried. Experience has shown that the use of cold water increases the washing time and the amount of carryover to the gas side.

5. Draft measurements: On several in-service washings draft measurements were taken in an attempt to follow the progress of the washing. However, owing to the low gas and air flows the draft measurements were meaningless and were discontinued.

6. Rate of moving wash nozzles: Wash-nozzle traverse rates of 1 in. every 2, 4, and 8 min have been tried. Results indicate that the rate of 1 in. every 2 min is most effective.

7. Balancing induced-draft fan speeds: During an in-service washing that was started with the induced-draft fan speeds unbalanced, the fan speeds were equalized. There was no evidence of any adverse effects, and the practice of unbalancing the induced-draft speeds was discontinued.

8. Hot-air recirculation: The amount of hot-air recirculation was varied on several occasions. It was found that the use of hot-air recirculation increased the temperature level at the cold end of the air preheater, reducing water carryover into the dust collector.

9. Washing time: Washing times ranging from 6 to 10 hr were investigated. The longer cleaning time definitely produced a more satisfactory cleaning.

Based on this experience, the authors made the following recommendations:

1. Most important is to keep surfaces dry: If a successful in-service washing is to be obtained, it is imperative that the entire air-preheater surface be kept dry except for the narrow annular band being washed.

2. Wash nozzles: Wash nozzles should be located on the air side both above and below the preheater.

3. Rotor speed: A rotor speed of ¼ rpm during in-service washing is recommended with a maximum permissible rotor speed of ½ rpm. Purpose of the low rotor speed is to reduce water carryover to the gas side.

4. Air velocity: Air velocity in the entering-air duct should be reduced to approximately 600 fpm to allow the wash water to fall freely to the bottom of the duct where it can be carried away by the drains. Excessive air velocity will cause the wash water to become entrained by the air stream and carried through the air preheater.

5. Washing time: Washing time must be varied in accordance with the size and dirtiness of the heater to be washed. When using wash water with a pH of 7 it has been found that excellent results were obtained when the pH of the effluent had increased to 5 from a value of about 1 at the start of washing.

6. Wash water: The recommended quantity, pressure, and temperature are as follows:

	FLOW gpm	PRESSURE psig	TEMP deg F
Upper nozzle (each)	20	18	180
Lower nozzle (each)	25	28	180

Alkaline treatment of the wash water does not seem to be necessary.

Conclusions: It is the opinion of the authors that in-service washing is a practical approach to the problem of cleaning air preheaters. It also provides a means for increased unit availability and improved boiler economy. As a result of the authors' successful in-service washing program, the average cold-end temperature of one St. Clair unit has been lowered from 200 to 180 F on a trial basis.

EBWR—First U. S.

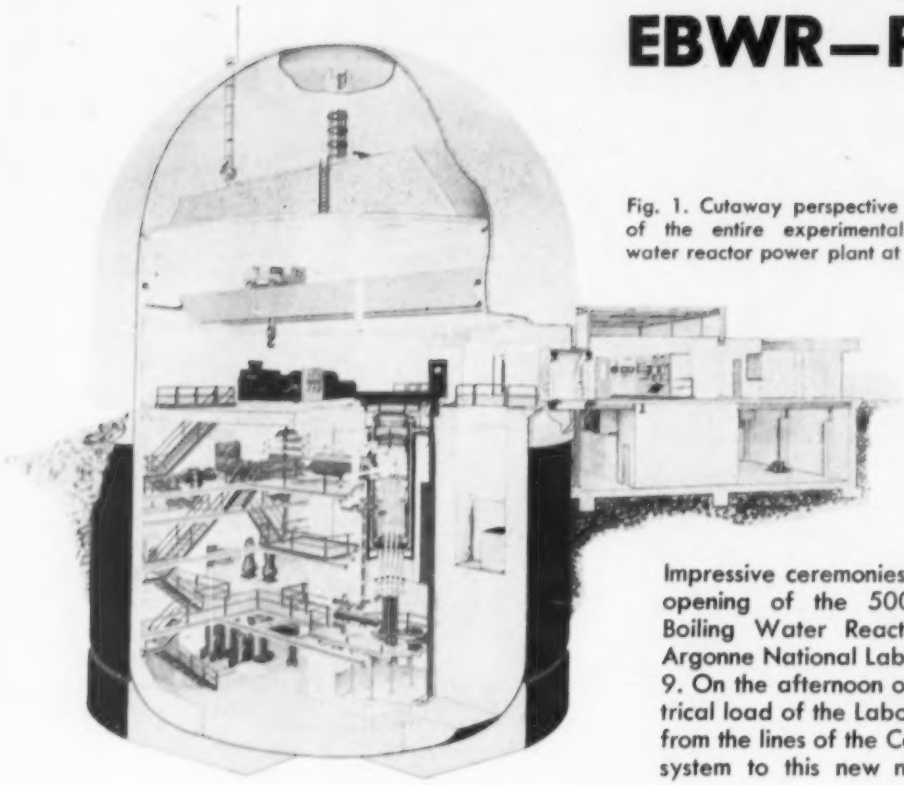


Fig. 1. Cutaway perspective drawing of the entire experimental boiling water reactor power plant at Argonne

Impressive ceremonies marked the official opening of the 5000-kw Experimental Boiling Water Reactor power plant at Argonne National Laboratory on February 9. On the afternoon of that day, the electrical load of the Laboratory was switched from the lines of the Commonwealth Edison system to this new nuclear power plant

ON FEBRUARY 9, EBWR, the first reactor in the AEC's power reactor program, was officially placed in operation. This 5000-kw (electrical) plant is the first nuclear power plant built specifically for power production to go into operation in the U. S. In attendance at the opening ceremonies were officials of the joint congressional committee, members of the AEC, and representatives of the University of Chicago which operates the laboratory for the Atomic Energy Commission. The size of this plant is not large in comparison with modern utility plants but was chosen to demonstrate the practicality of direct-boiling power reactors. This type of plant is much simpler than the pressurized water type, less costly, and is inherently self regulating and safe. At present the reactor operates with slightly enriched uranium fuel elements and with ordinary water. Later, it is expected to convert to the use of heavy water and with natural uranium as fuel. This plant will serve as a prototype for the 180,000-kw boiling water plant which the Commonwealth Edison Co expects to build some 40 miles south of Chicago in the near future. This will be known as the Dresden Station.

Fig. 2. A view in the control room of EBWR at a time when the plant is in operation. The man at the console controls the reactor; another man is taking data and a third operator is analyzing data. These 3 men have complete control of the plant

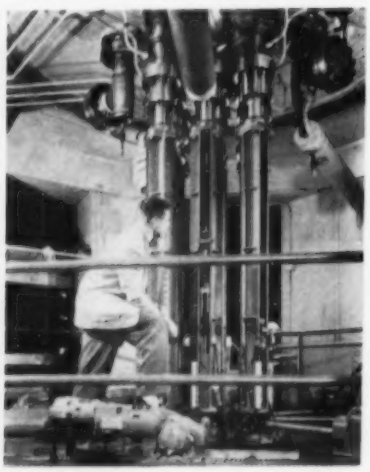


Fig. 3. The 9 control rods for the reactor are operated from underneath by these electrically operated mechanisms

Atomic Power Reactor in Operation

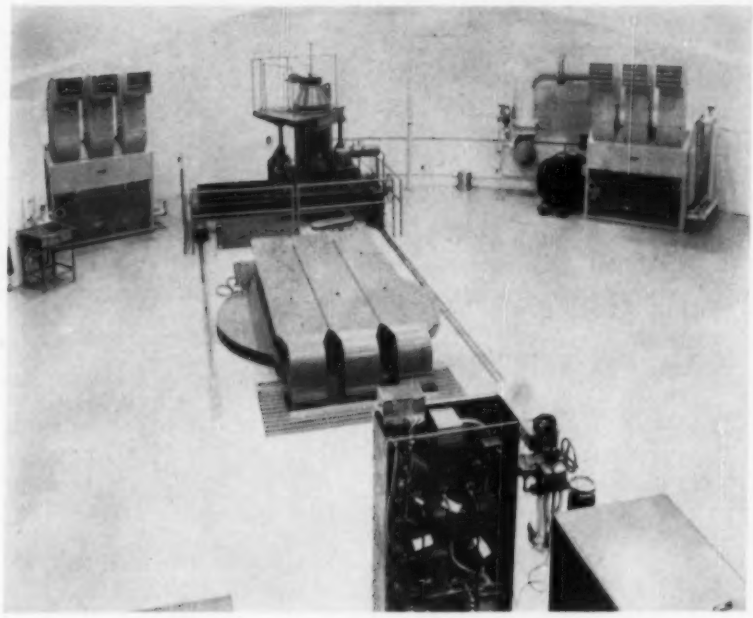


Fig. 4. (Left) Multiple steel beams on top of the reactor guarantee against an upward explosion in the reactor. These beams would direct the force of any explosion downward into the bottom of the reactor pressure vessel

Fig. 5. Management of the EBWR project at Argonne National Laboratory. Standing in front of the 5000-kw turbine-generating unit are: Joseph M. Harrer, project engineer; Norman Hillberry, deputy director of Argonne; L. W. Fromm, project engineer; John M. West, project manager, and Albert Jameson, project engineer

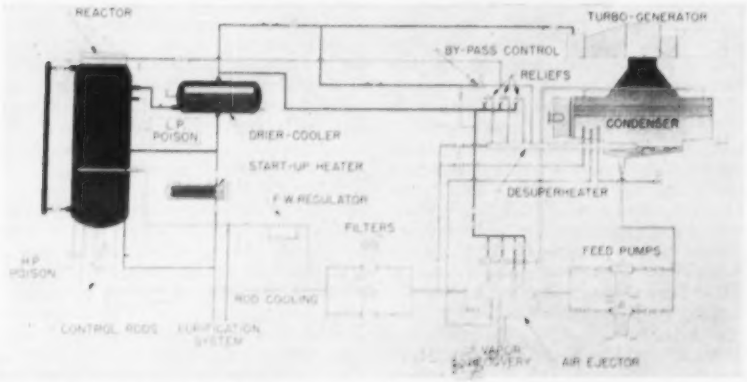


Fig. 6. Here is the EBWR flow diagram. Steam produced in the reactor passes directly to the steam turbine unit with no intermediate secondary heat exchangers

Fig. 7. The reactor core structure being lowered into the pressure vessel of the reactor. This structure serves to hold the fuel elements in the proper position as well as to guide the cross-shaped control rods. The lower part where the nuclear reaction takes place is made of zirconium; the upper part stainless steel

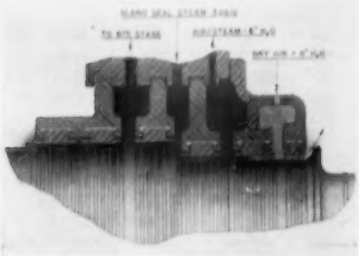


Fig. 8. Cross section of the multiple labyrinth seal on the steam turbine. This type of seal is used to prevent leakage of radioactive steam into the turbine room. This seal will also prevent the loss by leakage of valuable heavy water when the operation of the reactor will be converted to heavy water

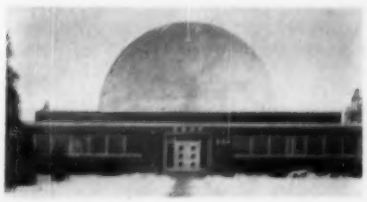


Fig. 9. Front view of the experimental boiling water reactor plant at Argonne

If your high-pressure centrifugal bf pump flashes at suction, should you shut it down at once? Or if you have half-capacity pumps, should you run both or shut one down if load drops so one pump can meet demand? Author gives answers and tells underlying reasons

How Do You Operate Your BF Pumps?

By I. J. KARASSIK *

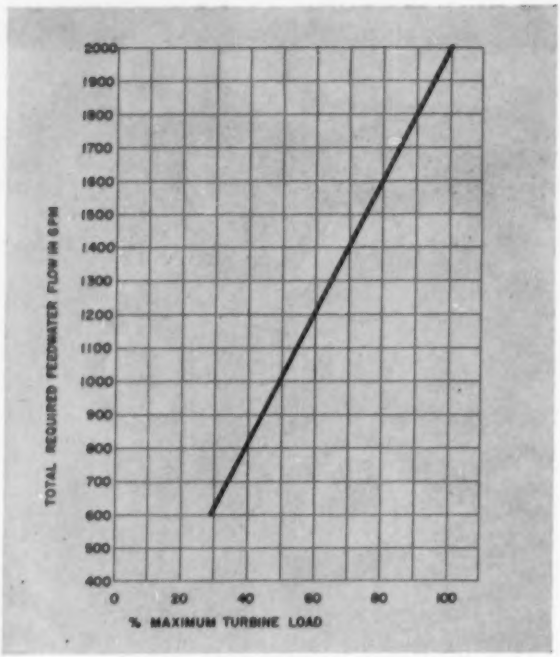


Fig. 1. Relation between turbine load and feedwater flow for large 1450-psi turbine-generator unit, served by three half-capacity boiler feed pumps, each one for 1100 gpm

CENTRIFUGAL boiler feed pumps designed to operate at discharge pressures in excess of 1000 psi have been built in the United States for over 30 years. In that time, their design has undergone a great deal of modification, brought about by field experience. Today, the design of high-pressure boiler feed pumps and the metallurgy used in their construction have progressed to the point that these pumps are capable of running from 60,000 to 120,000 hours between complete overhauls. And while these pumps have to be shut down every 6 to 24 months for the purpose of repacking the stuffing boxes, even this interruption in continuous service is in the process of disappearing since the development of the so-called "packless" stuffing boxes.

However, the steam power plant operator still faces the hazards of accidental interruption in the life of his boiler feeding equipment. Thus, the search continues for design improvements that can give a wider margin of safety against damage during transient operating conditions or accidents brought about by causes external to the pump itself. Transient conditions may have an injurious effect on the pumping equipment if, for instance, during a severe load drop occurring in a plant which incorporates a direct-contact heater at the pump suction, there takes place a deterioration in suction conditions leading to severe cavitation or even complete flashing of the feedwater.

Accidents may involve the introduction of foreign material, such as mill scale or hard oxide particles, into the system, which lead to pump seizure at the close internal clearances. Other accidents may involve the unintentional closing of suction valves, operation against complete shut-off without by-pass protection, or failure of the discharge check valve to close properly, causing reverse flow through the pump.

Effect of transient operating conditions and malfunctioning of equipment and apparatus intended to protect the boiler feed pump have been made the subject of numerous articles in the technical literature. (See references.) This article will discuss operating practices designed to further reduce operating hazards.

What of Suction Flashing?

First hazard we shall discuss is the effect of serious or even complete flashing at the pump suction. In the past, the majority of pump operators as well as of specialists in centrifugal pump application felt that the better part of valor was to stop the pump immediately and not restart it until conditions at the suction had been returned to normal.

However, within the recent months, I have become more and more convinced that whenever a high-pressure boiler feed pump becomes subject to flashing and cavitation due to operation under transient conditions, or through accidental mal-operation of the related equipment, it is a safer practice to permit the pump to stay on the line rather than shut it down.

This statement must be qualified by the assumption that the pump design is such that the shaft deflection is inferior to the internal clearances without any assistance from the wearing rings or other pump parts acting as water lubricated bearings. Logic of this qualification is evident from the consideration that, if the pump has become steam-bound, there is no longer any lubricating film at the running joints and the shaft assumes that deflection which it would have on the basis of a free shaft span between the two bearings.

Theory Plus Practice

This conviction with respect to the proper manner of treating a flashed pump is based both on theory and on actual observation in the field. Touching first on field experience, consider that no single case has been authenticated of a high-pressure boiler feed pump seizing at full speed. Whenever one of these pumps has seized, it is reported that the seizure occurred after power had been shut off from the pump driver and the unit was coasting to rest.

Two specific cases of field experience will bear reporting in some detail. In one case, during the initial operation of a new 100,000-kw unit, mal-functioning of some of the apparatus brought about a complete trip-out of the unit. The latter is served by three half-capacity boiler feed pumps, of which two were on the line and the third on standby. The

* Assistant to Vice-President and Consulting Engineer, Harrison Division, Worthington Corp

trip-out was followed by an almost instantaneous drop in pressure at the direct contact heater from approximately 50 psia to a 15-in. vacuum. This took place because the orifice in the line from the vent condenser to the main condenser had not yet been properly adjusted.

The suction header and the individual lines leading to each pump flashed in their entirety and complete cavitation took place. Discharge pressure gages on the boiler feed pumps went from a 2200 psi reading to zero, but fortunately the pumps were not shut down. This condition prevailed for some 2 to 3 min, at the end of which pressure was restored in the direct-contact heater. The pumps took on water and went back to normal operation. Subsequent tests determined that no injury had taken place internally and that pump performance had not been impaired.

In another case, where three high-pressure boiler feed pumps were temporarily on the line, all operating at almost their rated load, the valve in the main suction header was inadvertently closed. Of course, the pumps flashed immediately and the discharge pressure gage reading fell to zero. Here again the pumps were left on the line and the suction valve was reopened some 2½ min later. Again, in this case, the pumps returned to normal operation and further checks indicated that no internal damage had taken place.

If Pump Seizes—What Then?

Typical sequence of events when a pump seizes is this: as soon as suction difficulties are noted, power is cut off to the driver and the pump starts coasting to rest. In some cases, the operator notices an internal noise, in others no noise. Vibration may or may not be noted as the pump slows down. Frequently, operators may report a more rapid deceleration just before the pump comes to a complete rest. An attempt to turn the rotor over by hand later on discloses that the pump has seized at some internal running joint. Examination of the dismantled pump then uncovers whatever damage has taken place internally.

While it is rare that operators will restart a pump after they suspect internal seizure without first trying to rotate it by hand, one such typical case has recently come to my attention. The pump was connected to its driving motor through a hydraulic coupling. It was started up inadvertently in a completely steam-bound condition. On finding that no water was delivered to the boiler, the pump was shut down and the difficulties at the suction remedied. On restarting the pump, it was discovered that the motor came up to speed all right, but that the pump remained stationary, the hydraulic coupling providing full slip. The pump was dismantled and was found to have seized very badly, with the rotating and stationary parts of the balancing

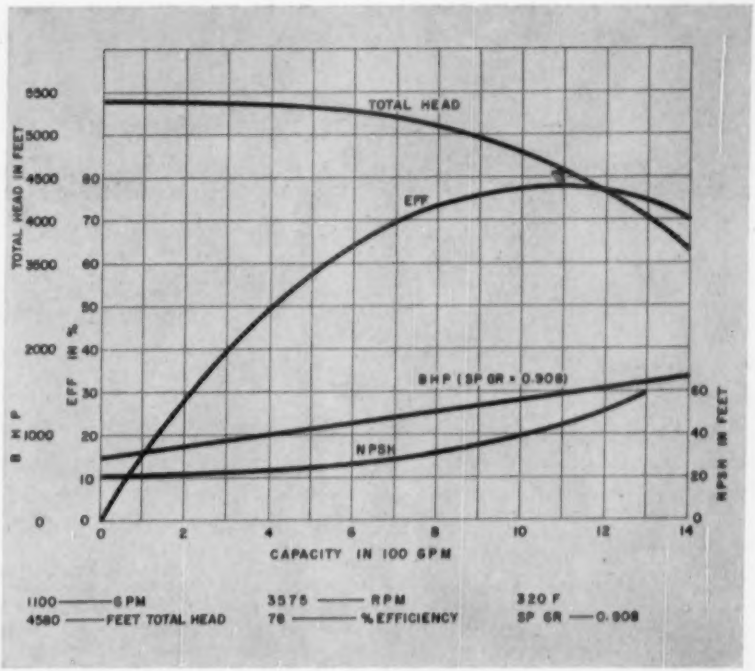


Fig. 2. Performance of the individual boiler feed pumps for the unit of Fig. 1. Feedwater temperature variation with the load is neglected here for simplicity

device completely welded into a single mass. My opinion is now that if the pump had remained on the line, while suction conditions were being restored, no serious damage would have taken place.

Leave Pump Running

Theoretical background for the recommendation to leave the pumps running is the following: if flashing is rapid and no excessive vibration takes place because the pump has a short shaft span, large shaft diameter and liberal clearances, so that it does not depend on water lubrication at the wearing rings, the pump simply begins to operate as a steam compressor. Of course, while it develops the same adiabatic total head in foot-pounds per pound of steam, the pressure it develops in psi is negligible. When water supply is restored, however, the pump returns to normal operation.

Even if some slight vibration does take place and slight contact occurs at some internal portion of the pump (such as at a wearing ring), the drag torque is so much below the available torque from the driver that no seizure takes place. At worst, one of the wearing rings becomes slightly damaged and its clearance is increased. In a multi-stage pump, the effect of such damage is not noticeable without the help of field instrumentation.

However, if power is cut off from the driver, no torque is available other than the inertia of the driver and pump rotors. As the unit slows down, this torque is insufficient to prevent the drag torque at the contact point from causing the pump to seize. In addition, as the pump is slowed down, it passes through the critical speed of its rotor and, lacking the damping effect of liquid within the pump, the vibration incurred is considerably greater than if the pump were left running, even though fully steam-bound.

We must admit that recommending to leave a steam-bound boiler feed pump on the line appears to be quite a revolutionary departure from accepted practice. Nevertheless, the facts seem to indicate that this is sound advice, especially in the case of a pump built for low deflection and ample clearances. If, in a rare case, following this advice leads to a pump seizure, one can be certain that shutting the pump down would have led to the same result.

What About Half-Capacity?

A large number of steam power plants are provided with three "half-capacity" boiler feed pumps to serve each main unit. Two of these pumps are operated in parallel to deliver the required feedwater flow at full load, while the third pump serves as a standby. We shall not discuss here the relative merits of using a single full-capacity pump or two half-capacity pumps for full load conditions, as an analysis of this problem is available elsewhere in technical literature.* We shall concern ourselves instead with the controversy which

* How Many Feed Pumps Should You Specify? By I. J. Karassik, *Consulting Engineer*, February 1955.

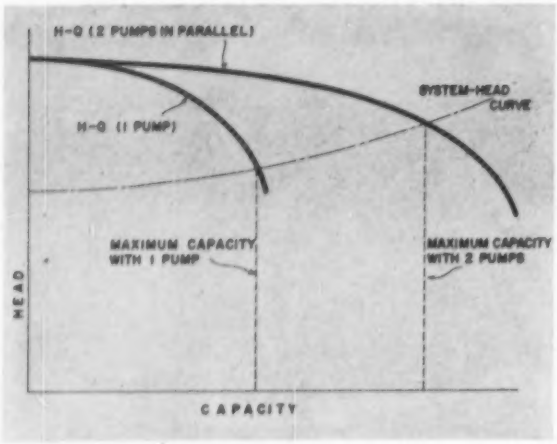


Fig. 3. System-head curve, with feedwater regulator wide open, with head-capacity curves of both one and two parallel pumps. Intersections show capacity they can handle

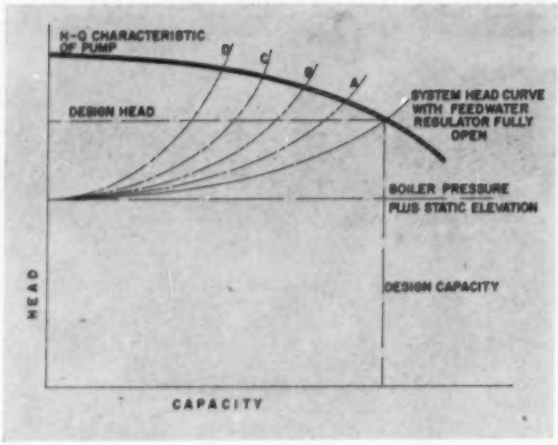


Fig. 4. To obtain flows of lower magnitude than in Fig. 3, with one or two pumps, system-head curve is artificially altered thus by closing of feedwater regulator, as explained

arises very frequently between operators who use half-capacity pumps; namely, should two pumps be kept on the line at all times or should one of the pumps be shut down when the load drops to a point where a single pump can meet the demand for feedwater?

Both schools of thought have their adherents and my experience would indicate that power plant operators are fairly evenly divided in their opinion on this question. Those who prefer to shut a pump down whenever it is no longer needed argue that they can save power by so doing, and that they lengthen the life of their equipment. Operators who keep two pumps on the line at all times claim that they have greater safety because, if one pump were to fail, they could still feed the boiler without interruption while the standby pump is brought into service.

Typical Example

These are rather general statements and deserve to be examined in greater detail. To this end, we shall select for our example a large turbine-generator operating at 1450 psi and served by three half-capacity pumps. Relation between the turbine load and the feedwater flow required is shown on Fig. 1. The pumps are designed for 1100 gpm each, so that they will have a margin of 10 per cent when operating in parallel over the flow required at maximum (not rated) load. Performance of the boiler feed pumps is shown in Fig. 2. For simplicity, effect of feedwater temperature variation with the load is neglected, and it is assumed that the pumps handle 320-F feedwater with specific gravity of 0.908 at all loads.

In order to predict the capacity that can be delivered by a given centrifugal pump or group of pumps, when operating in a given system, it is the practice to plot a system-head curve and superimpose on it the head-capacity curve of the pump or group of pumps. The intersection of these curves will then determine the maximum capacity which can be handled in the system. This method is illustrated in Fig. 3, where the system-head curve is shown with the feedwater regulator wide open. Obviously, to obtain flows of lower magnitude with either one or two pumps on the line, the system-head curve has to be artificially altered by the gradual closing of the feedwater regulator as shown in Fig. 4.

Thus, in the case of the pumps whose performance is illustrated in Fig. 2, the feedwater regulator would be slightly closed when the turbine is carrying 100 per cent of maximum load, to limit the feedwater flow to 2000 gpm total, or 1000 gpm per pump. Under these conditions, the pumps will develop a total head of 4750 ft with an efficiency of 77.5 per cent and take 1402 bhp each. The total power consumption is 2804 bhp.

With 50 Per Cent Load

Let us see what happens when the turbine load is reduced to 50 per cent of maximum. Total required flow becomes 1010 gpm and it can be met either by continuing to operate two pumps each handling 505 gpm or shutting one pump down and delivering 1010 gpm with the remaining unit.

In the first case, at 505 gpm, the pumps develop 5300 ft total head with 57.5 per cent efficiency and take 1067 bhp each. The total power consumption is therefore 2134 bhp.

If, however, we meet these conditions with a single pump, it operates at about 77.5 per cent with a reduced head and consumes 1410 bhp — a saving of 724 bhp over using two pumps. It is fairly obvious, therefore, that the claim for power savings, by the proponents of an operating method that shuts pumps down as soon as the load can be carried with a single pump, is well founded.

It seems that their claim for longer equipment life is equally sound. In the first place, whenever the station load is reduced to the point where one pump carries the load, operating hours cease to accumulate for the pump which has been shut down. If we assume 8500 operating hours for the station, of which 20 per cent takes place at loads of 50 per cent of maximum or lower, each pump operates only 7650 hours a year instead of 8500 (assuming that the standby pump is always kept in reserve).

Effect on Pump Life

But more important than this straight arithmetical effect is the difference in the result on the pump ultimate life. For a pump which frequently operates at reduced capacities does not have as good a life as a pump operated more nearly at its best efficiency point. In other words, a pump operating back on its curve at 57.5 per cent efficiency wears more than a pump operating close to its best efficiency point — at 77.5 per cent in this case.

What of the safety argument? I am afraid that it is slightly in error because an equally good case can be made for running a single pump at light loads. If emergency conditions are considered and an accident occurs when two pumps are on the line, there is a reasonable possibility that both pumps would have been damaged. This is especially true if the accident concerns suction difficulties and flashing in the suction header. If, on the other hand, only one pump was on the line at that moment, after suction conditions have been reëstablished there still remain two pumps to put into service and full load can be carried even while the damaged pump is being repaired.

As to the *continued on page 102*

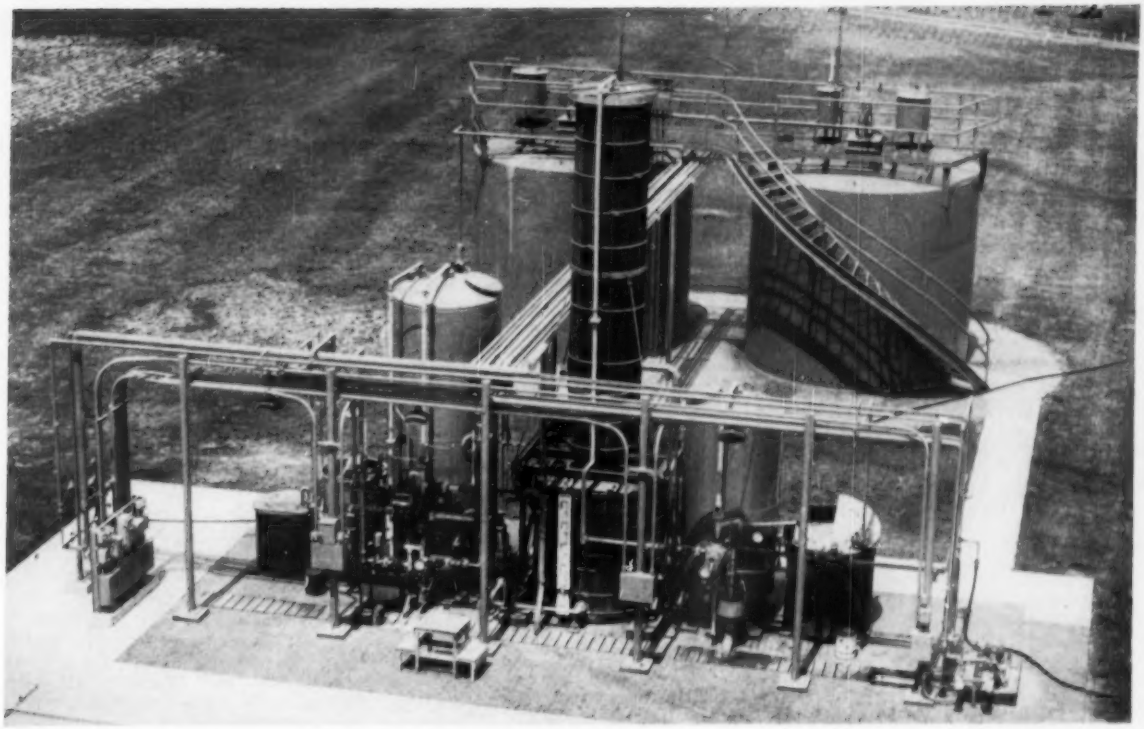


Fig. 1. General view of demineralization plant. Note small measuring tanks above storage tanks in background. Caustic unloading pump is in lower right foreground

Webster Plant Uses Manual Operation on 2-Step Mixed-Bed Demineralizer

Why it was chosen for first and second demineralizers at Webster Plant of Houston Lighting & Power Co and how it worked out. After nearly 3 years, performance of units exceeds expectations

By S. ALFANO *

IN 1952, when the present demineralizer was first considered, the reliability of these units to supply good make-up requirements for high pressure boilers was questioned. There were also doubts whether ordinary personnel could manipulate these units. Should the units be designed for manual operation or for complete automation?

It was decided then to bridge the path from evaporation of make-up to deionization by purchasing a deionization unit and an evaporator instead of two deionization units. An evaporator rated at 30,000 lb vapor per hr and a manually operated demineralizer rated at 66,000 gal per 24 hr cycle were purchased to serve a 1500-psi, 1000-F, 1,000,000-lb-per hr steam generator. A similar but larger unit has been ordered for the next expansion.

Thus, in May 1954, the Webster Plant, the latest addition to the Houston Lighting & Power System, was started to serve the increased load on the system.

From May 3, 1954 to September 30, 1956 more than 200 cycles have been run through the demineralizer plant. Several of these cycles were run to waste for experimental purposes. Approximately 16,000,000 gal have been processed for use.

All these cycles have been operated manually. On the basis of our experience we believe the choice of manual operation over automatic was a good one. This is not to say that the technique of regenerating is not adaptable to automation. It is, but the particular behavior of our unit would have forced us to bypass automation for a time until the faults could have been cured. As it is, the operator manipulates to secure the proper condition regardless of which component fails.

In general, this and another larger unit designed by the manufacturer (ILLCO) have exceeded our expectations. The first unit, purchased for 40 gpm and 56,000 gallons per cycle, has performed at over 150 per cent of designed condition. The second unit, now undergoing its 50th cycle, was designed for 75 gpm and 100,000 gallons per cycle; it is performing at 150 gpm and yields over 200,000 gallons per cycle.

The first deionization unit consists of the following:

1. A single cation unit 54 in. diam by 96 in. high charged with 63 cu ft of Illco C211 (identified in industry by its full name, Nalcite HCR, (Dowex 50).

2. An aerator — 36 in. by 192 in. high equipped with a 250 cfm blower at 3.3. in. water.

3. An aerator well holding approximately 1,000 gal.

*Houston Lighting & Power Co.

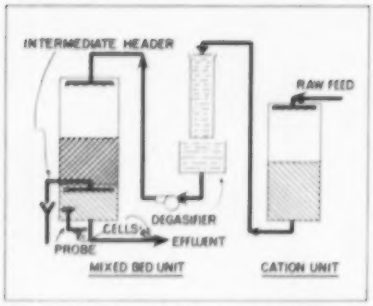


Fig. 2. Schematic diagram of deionizer

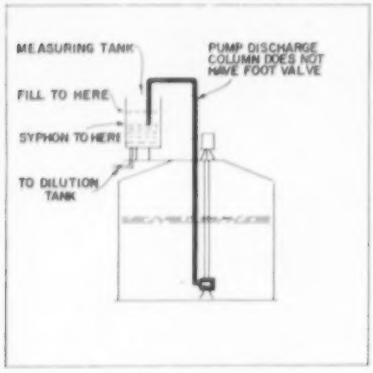


Fig. 3. Method of withdrawing regenerant chemicals from main storage

4. A mixed bed unit — 60 in. diam by 144 in. high charged with 69 cu ft of a strong base anion resin known as Nalco SBR, together with 46 cu ft of additional cation resin Nalcite HCR.

Figure 2 shows a schematic flow diagram for the deionizer.

Other accessories are as follows:

1. A 12,000-gal concentrated acid storage tank.

2. A 12,000-gal 50 per cent liquid caustic storage tank.

3. Withdrawal pumps of the bilge or sump type immersed in these strong chemicals and delivering regenerants overhead to measuring tanks.

4. Dilution tanks in which the strong measured chemicals are diluted with water and mixed. The flow from the measuring tanks to dilution tanks is by gravity. The measuring tanks are located on top of the storage tanks. Method of withdrawing regenerant chemicals is shown in Fig. 3.

Regenerant Chemicals

The cation unit is regenerated with 6 lb of 66 Bé sulfuric acid per cu ft of resin or a total of 378 lb of acid.

This amount of acid will allow the cation unit to produce 75,000 gal of effluent still containing enough free mineral acidity to strip off the combined CO_2 and free CO_2 in the water entering the aerator. There is however, some sodium in the product, but no hardness. The hardness-free, nearly sodium-free capacity is 66,000 gal. Operation of the cation unit results in an effluent costing 5.10 cents per 1,000 gal of treated water.

The mixed bed unit is regenerated with 6 lb of acid per cu ft of cation ion resin component and with 8 lb of dry caustic per cu ft of anion resin component. The chemicals for the mixed bed consist of 276 lb of acid and 552 lb of caustic (dry basis). At $20.65 per ton for 96 per cent acid and $2.87 per cwt dry basis for caustic soda, the combined chemical cost for the mixed bed operation becomes $18.70 per cycle. The mixed bed is good for 100,000 gal of acceptable product.

Specific chemical cost for demineralized water is 18.7 plus 5.1 or 23.8 cents per 1,000 gal of acceptable water. The unit was purchased to demineralize 66,000 gal of well water to a product containing not more than 0.01 ppm silica for 95 per cent of its cycle.

Water for the deionizer (DI) is taken from deepwells at the plant site. The characteristic of this water is not expected to change. Its analysis is as follows:

Sodium bicarbonate	(as $CaCO_3$)	206 ppm
Calcium & Magnesium bicarbonate	(as $CaCO_3$)	45
Methyl orange alkalinity	(as $CaCO_3$)	251
Sodium sulfate	(as Na_2SO_4)	2
Sodium chloride	(as NaCl)	85
Silica	(as SiO_2)	27
Total solids		365

The guarantees and the presently applied chemical dosages are:

	Guarantee	Actual
Cation Acid	378 lb	378 lb
Mixed bed acid	288 lb	276 lb
Mixed bed caustic	278 lb	552 lb
Water Treated, Gal—Cation	66,000	75,000
Water Treated Gal—Mixed Bed	66,000	100,000
Silica in Product Actua	0.025-0.05*	0.003
Raw Feed Total Cations—PPM	365	365
Total Silica in Raw Feed—PPM	27	27
Free Mineral Acidity outlet Cation PPM	72	72
Ratio SiO_2 to Mineral Acidity	0.38	0.38

* Guarantee of 0.01 ppm Silica could not be attained at 4 lb caustic.

It is seen that the silica component entering the mixed bed unit is over $\frac{1}{3}$ of the free mineral acidity. Thus, the mixed bed unit has a considerable silica load to carry.

Essentially the process is as follows:

Raw water enters the decationizer where all the calcium, magnesium and nearly all the sodium is absorbed. A small amount of sodium leaks through, 12 to 26 ppm. The effluent containing free CO_2 and free hydrochloric acid (HCl), enters the degasifier.

On cascading down the aerator the water has its free CO_2 removed. The water is received in a redwood tank located below the aerator. The pH of the water at this point is 2.7, the free CO_2 is less than 5 ppm.

These conditions are true for nearly 66,000 gal. An additional 9,000 gal is processed with an attending diminution of free mineral acidity. When the effluent shows complete absence of free mineral acidity it is regenerated.

From the redwood tank the water is then picked up by a pump and passed through the mixed bed. In passing through this mixed bed, the water has all of its free mineral acidity removed including free CO_2 and other anions that may have passed through the decationizer as neutral salts after exhaustion of the cation resin.

Effluent from the mixed bed is stored in the plant's condensate storage tank. The quality of the water as finally processed is as follows: Silica, zero to 0.005 ppm, average 0.003 ppm. Other solids are immeasurable. Resistivity was in excess of the Solubridge range of 18 megohms for the first 120 cycles decreasing to 8 megohms after 200 cycles. The cation resin has experienced no loss in efficiency. The strong base resin has lost 16 per cent in its exchange capacity.

The pipe conducting demineralized water to the tank is made of brass. The condensate storage tank was painted inside with a plastic paint.

Operation and Performance

After 200 cycles of regeneration and operation, the writer feels that what at first appeared to be irritating situations are now inconsequential. Regenerating and operating the unit is now a simple matter.

The early difficulties, their solution and final operational procedure will now be related.

There are a few features of the design which we, as first users of such equipment, could not very well have anticipated, but regarding which would have expected the manufacturer to have done better.

Probe Position

The unit was equipped with a probe sampler. The purpose of this probe is to anticipate exhaustion. Hence it was placed 2 in. from the bottom. This would allow the last two inches of resin to defend against ion breakthrough. The sampling tube was made of $\frac{1}{4}$ in. stainless steel and placed 6 in. from the side wall. So located, the probe was never anticipatory. In fact, long after the ions had broken through, the probe was revealing acceptable water.

This fault was easily corrected. The probe was raised 10 in. from the bottom and instead of it being a $\frac{1}{4}$ in. opening, it is now teed to 12 in. on the horizontal.

The small probe field did not represent the conditions of the water at the plane of the probe. In its location it did not anticipate exhaustion. This

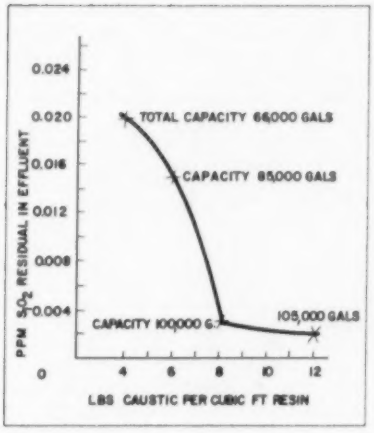


Fig. 5. Average performance of anion resin for several caustic proportions

proved that the downward flow path of the water eventually converged into a cone, the flow gathering toward the central 2-in. outlet. This, indeed, revealed the limitations which a gathering manifold has in its inability to induce vertical uniform down flow to its central hub.

According to Fig. 4 the expected exchange capacity of the mixed resin is 1500 gal per in. of resin. However, only 6000 gal are processed from the probe point to tank bottom outlet. It can be concluded that the lower 10 in. of the resin is 40 per cent effective. The remaining 60 per cent is nullified because the water flow path shunts the portion of the resin farthest from the central outlet. The probe sampler was formerly positioned in this little used portion of the resin with the result that the sample was always deionized by a considerable depth of resin that was seldom exhausted.

Some minor equipment faults were easily remedied. For example, Uscolite air manifolds within the acid dilution tank have failed. The heat of solution on mixing acid with water distorts these plastics, which are affected by temperature. Where temperatures above 150 F are encountered the plastic will be replaced on failure with rubber lined steel.

After 10 cycles, the intermediate regenerant manifold in the mixed bed located at the interface between the cation and anion resins failed. However, 6 cycles were made without suffering any loss in quality without the use of this manifold. This attests to the flexibility that is inherent in a manually operated unit of this type.

One of the 16 Saran screened spokes of this manifold had unthreaded itself loose from the center hub. This resulted in an unscreened hole of 1-in. diameter exposed to the resin material. Little resin was lost before the drain valve was closed.

There was no doubt that this spoke was not properly secured on construction. It took 2 hours to empty the tank and 6 hours to repair and recharge the tank of its contents. No further equipment fault has since been experienced.

The unit was designed to produce water containing not more than 0.01 ppm of silica for 95 per cent of its run when using 4 lb of dry caustic per cu ft of anion resin.

Amount of Caustic

Some cycles were run using varying amounts of caustic. The average performance of the anion resin using 4, 6, 8 and 12 lb of caustic per cu ft of resin is shown in Fig. 5. The operators have settled on 8 lb of caustic per cu ft of anion resin. While doubling the caustic affected the residual silica in the effluent it did not quite double the quantity of water processed.

In studying the exchange capability of the resin it was found that silica moves within the bed in waves of maximum concentration. For the particular water in this case and the specific size of tank it was noted that the silica always appeared in the flow stream in concentrations reaching 200 ppm.

Since this is a production unit and not an experimental one, the number of sampling points are limited to 3. But from analysis of the water at these 3 points the writer sought to reconstruct the graph showing how silica may vary within the resin bed.

The 3 sampling points are: 1, the intermediate collecting manifold located 36 in. from the bottom; 2, the probe point located 10 in. from the bottom, and 3, the bottom outlet.

Silica Concentration

As shown in Fig. 3 water containing actually 52 ppm of hydrochloric acid and 27 ppm of silica, enters the top of the tank. After some 50,000 gal are processed, the analysis of the water taken at the intermediate manifold begins to show silica breakthrough. After an additional 4000 gal is passed, the silica rises to a maximum of 200 ppm. By the time the silica begins to show at the probe point, the silica concentration has dropped to 50 ppm at the intermediate header. The same rise and fall of silica is noted at the probe point.

Likewise by allowing the water to flow to waste the same peak of silica is noted in the bottom outlet.

This suggests the possibility that side taps could be used to purge out the cumulative buildup of silica. Indeed, it is a correct operational procedure to continue the run to waste until all the silica has been rejected. This reduces the silica concentration within the resin on subsequent elution (separation or purification by washing) of regenerant.

Having discovered the ease by which silica can be desorbed from the anion resin by the small concentration of hydrochloric acid associated with the silica, it was decided to establish the feasibility of desorbing the silica in the exhausted bed with acid in lieu of caustic.

Four cycles were regenerated in this manner. The following procedu re was improvised:

Following the regeneration of the cation unit, a quantity of acid equal to 25 per cent of the regenerant charge of the cation component of the mixed bed was passed through the cation unit (which already had all of its cations desorbed), then to the degasifier, thence through the mixed bed. It is very important not to disturb the mixed bed since the silica has accumulated at its lower extremities.

The acid regenerant varying in concentration from trace to fractional per cent strength was allowed to pass through the mixed bed at the following rates and time:

Time Interval	SiO_2 ppm In Eluant	Gpm	Gal	lb Silica
10	6	40	400	02
10	40	40	400	.13
2	150	40	80	.10
2	170	40	80	.12
4	250	40	160	.33
2	300	60	120	.30
5	340	60	300	.90
5	260	80	400	.90
10	200	80	800	1.33
5	100	80	400	.33
10	70	80	800	.47
10	50	40	400	.17
Total			4,340 gal	5.10 of SiO_2

Thus, by using 70 lb of sulphuric acid in 4340 gal of water a total of 5.1 lb of silica was desorbed. The amount of water processed gave up 15 lb of silica. Hence, 33 per cent of the silica was desorbed and at the same time the high concentration zone was eliminated.

Three other efforts along this line used more acid with attending more removal of silica. A particular regeneration in this manner, using strong acid solution in quantities equal to the needs of sound regeneration dosages for the cation component of the mixed bed, resulted in the highest quantity of desorbed silica together with complete regeneration of the cation resin. Subsequently, only the anion resin component was regenerated. The performance of the unit under this procedure gave a superior product with respect to silica removal.

Since the layout of the unit does not lend itself to this technique, it is not being done with regularity. It will be done at intervals of 20 cycles at least. This method removes any accumulation of calcium, magnesium and iron depositions within the mixed bed. Such chance deposition is likely to occur when these ions are subject to contact with caustic solution. It were better if this technique could be applied regularly since the resins would be left in their most effective condition free of iron and other deposition.

Backwash must start with freeboard above the resin void of water. Classification from the backwash must be effected in the time it takes to fill the freeboard. This takes 12 min at 90 gal per min and suffices for

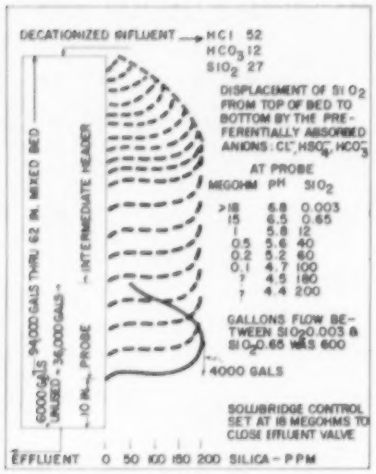

DECATIONIZED INFLUENT
HCl 52
HCO_3 12
SiO_2 27
DISPLACEMENT OF SiO_2 FROM TOP OF BED TO BOTTOM BY THE PREFERENTIALLY ABSORBED ANIONS: Cl^-, HSO_4^-, HCO_3^-
AT PROBE
MEGOHM pH SiO_2
>18 6.8 0.003
15 6.5 0.65
1 5.8 12
0.5 5.6 40
0.2 5.2 60
0.1 4.7 100
? 4.5 180
? 4.4 200
GALLONS FLOW BETWEEN SiO_2 0.003 & SiO_2 0.65 WAS 600
4000 GALS
SOLUBRIDGE CONTROL SET AT 18 MEGOHMS TO CLOSE EFFLUENT VALVE
6000 GALS 94,000 GALS THRU 62 IN. MIXED BED
UNUSED - 34,000 GALS
INTERMEDIATE HEADER
10 IN. PROBE
EFFLUENT
0 50 100 150 200 SILICA - PPM

Fig. 4. Diagram showing how silica travels within mixed bed in waves reaching max concentration of 200 ppm

complete classification of the 2 resins wherein the lighter anion resin accumulates at the top and the heavier cation resin settles at the bottom with a distinct boundary between the 2 resins. The intermediate collecting manifold lies in this interface.

Advantage of Manual Operation

It is evident that manual operation allows the operator to be present during regeneration. There he is alert to any situation that may arise. He is there to avert loss of resin which may occur from backwash or from equipment failure. He is there to satisfy himself that the 2 resins have been properly fluidized, mixed and correctly set before going on stream. And finally he is there to see that effluent is acceptable and, if not, is there to start all over again to see to it that the product is acceptable.

In an effort to resolve the issue between multiple single beds and mixed beds, this unit was operated for 3 cycles as a single bed. After regeneration the bed was not mixed but lay classified. The intermediate header located at the bottom of the anion resin served as the effluent outlet.

As a consequence, at 8 lb of caustic per cu ft of resin the effluent was inferior with respect to silica removal. The lowest silica was 0.025 ppm. The total quantity at this optimum silica performance was less than when mixed. In all cases the decationizer unit was conditioned for least sodium breakthrough. Complete, thorough mixing of resins is a necessary function for complete silica removal.

The most economical caustic dosage for maximum anion removal with decent silica removal appears to be a 4 lb of caustic per cu ft of resin. But to realize a superior product with the absolute least amount of silica in the effluent higher caustic dosages seem probable, as in Fig. 2.

One may ask, "How much is 0.005 ppm silica worth instead of 0.025 ppm in the make-up?" Especially when make-up requirements are less than ¼ per cent of boiler flow. Is it worth the effort to achieve it? (This is a matter of opinion.)

It is the writer's impression at this stage of development that fabrication of these demineralizers has followed too closely the orthodox design of the older zeolites.

Introducing Regenerant

For example, considerable design effort is expended to devise means of introducing regenerant chemicals. Concerning caustic, there is the added effort to heat it to 95 F.

The proper thing to do is to utilize the freeboard above the resin as the place to effect solution. Together with this, the heat of dilution of caustic will effect the necessary temperature rise. It is fortunate that the freeboard above the resin contains the necessary volume within which the necessary regenerant strength may be affected. It is a simple matter to pump the strong chemical in the freeboard, then agitate with air, then displace the regenerant with controlled flow.

Another time saving procedure is to design quick dump lines to expedite draining of excess water before mixing.

There is still doubt in some people's minds whether demineralization of make-up water should supplant evaporation. Aside from considerations such as effects on plant thermal economy, the opinions on this issue are still divided. How can the issue be resolved?

A simple criterion would be to ask those who now have had experience with both and note their preference. All the operators and engineers at Webster prefer deionization. Only where DI is used for make-up has the silica in the boiler been held below 1 ppm.

Some of the pros and cons about the issue are tabulated below:

Relative Performance

	DI	Evap
1. Pure water available when main unit is shut down	Yes	No
2. Standby unit is equivalent to storage reservoir.	Yes	No
3. Maximum rates at low station loading.	Yes	No
4. Instantaneous response to needs.	Yes	No
5. Quality excellent at over ratings.	Yes	No
6. High quality during load surges.	Yes	No
7. Eliminates CO_2 completely.	Yes	No
8. Reduces venting and other losses.	Yes	No
9. Total dissolved solids below 0.25 ppm.	Yes	No
10. Quality of product 2 to 20 megohms resistivity.	Yes	No
11. Silica below 0.01 ppm when operating smoothly.	Yes	Yes
12. Simplicity of operation.	Yes	Yes
13. Ordinary personnel required.	Yes	Yes
14. Eliminates scale in make-up system.	Yes	No

Summary

Experience during 200 cycles of operation has shown that manual operation of a demineralizer is no different from the operation of an ordinary zeolite. It is the conviction that an operator be on hand to view the regeneration cycle.

Performance with respect to silica removal depends on caustic dosage. Proper mixing of the resins in the mixed bed unit is a most necessary function. It has been shown that silica travels within the bed in waves reaching a maximum concentration of 200 ppm. This has suggested the possibility that subsequent regeneration after exhaustion can be improved if this silica wave is rejected to waste.

Preferentially absorbed ions of Cl^-, HSO_4^-, HCO_3^-, displace silica from the bed. This suggested the procedure of desorbing all the silica with the requisite amount of acid which is necessary to reactivate the cation component of the mixed bed.

Chemical control of the process is certain, notwithstanding small concentrations to be analyzed.

Analytical techniques have been developed which reveal the extent of silica presence in water. Another paper will explain the methods employed.

In conjunction with this study it was shown that the solubility of silica in steam at 1500 psi is 1 per cent of the dissolved silica in the boiler water.

However, silica in steam sampled from the standard perforated probes in the steam drum did not show silica concentrations to be the same as found in the high-pressure heater drips and in the condenser condensate. Steam entrainment can be ascertained by careful analysis of silica. Present methods of steam sampling through the perforated nipples in the drum needs re-appraisal.

There is some doubt that present steam sampling devices are adequate to reveal the true performance of a steam generator.

Continued prevalence of silica during its early history in boiler water in spite of liberal blow-downs suggest that a new plant contains latent silica constituents which slowly dissolve in the water. It takes 2 months before silica levels are stabilized to less than 1 ppm.

Some design suggestions are presented whereby the admission of chemical regenerants may be facilitated together with the idea of appropriating the intrinsic heat of dilution of caustic and water thereby precluding caustic heating.

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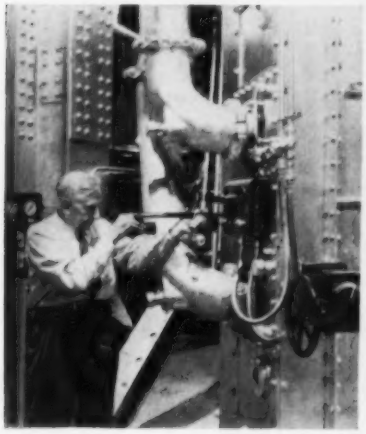
Fig. 1 (Below). A. S. Oliver, superintendent of steam and power at the Minnesota and Ontario Paper Co's (Mando) International Falls, Minn., mill, starts up this recently-completed boiler



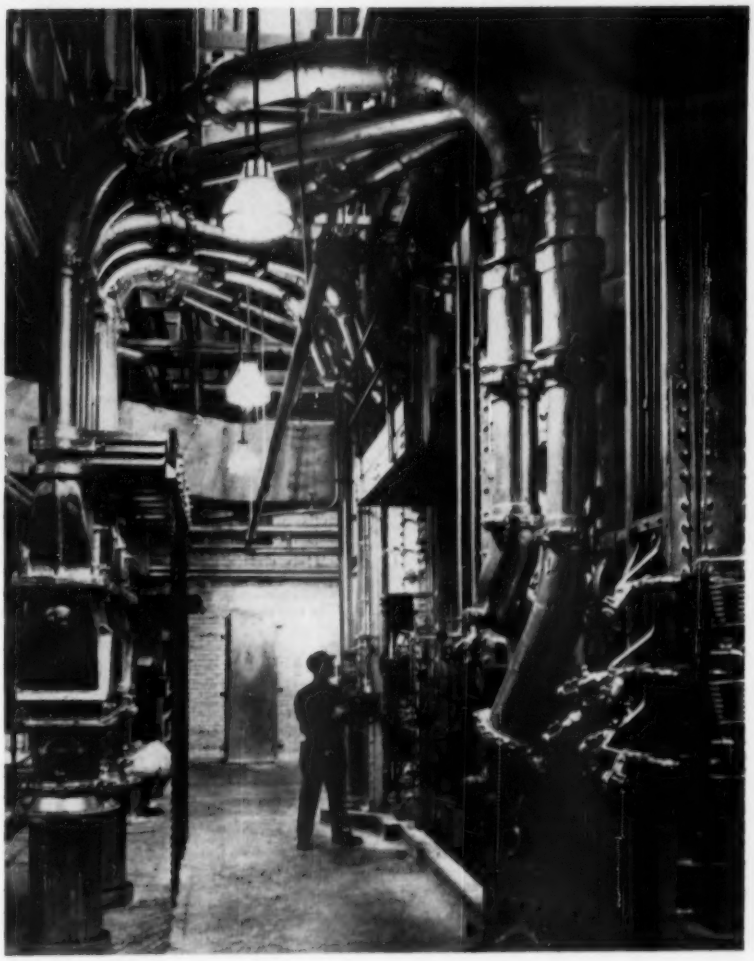


Fig. 2 (Right). Sparkling new, covered with aluminum paint, this boiler, fired by pulverized coal, has just gone into operation at the International Falls mill

Rated at 240,000 lb per hr, generates at 1290 psi, 800 F. Supplies steam to 6200-kw topping turbine-generator, which exhausts at 425 psi, 580 F to existing 425-psi turbine generators furnishing 165-psi and 35-psi extraction steam to mill. Number of existing 450-psi boilers and recovery boilers tie into steam system. This new unit is part of big capital improvement system now under way by Minnesota and Ontario Paper Co. **Detailed list of main equipment and auxiliaries is available on request to the Editor**

Mando Installs New Steam Generator And Topping Turbine

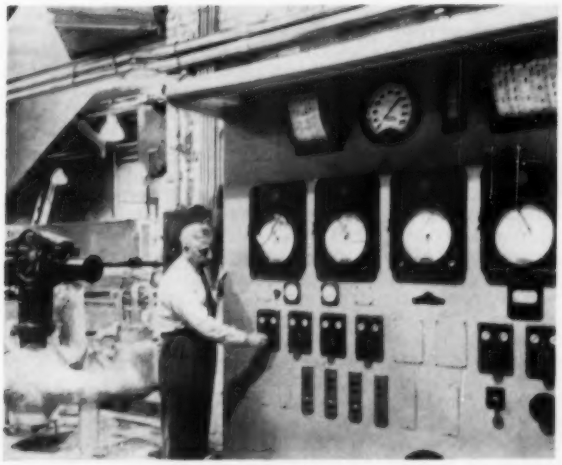


Fig. 3. Superintendent Oliver checks boiler control panel of new boiler unit, now equipped to burn coal, lignite, gas or oil

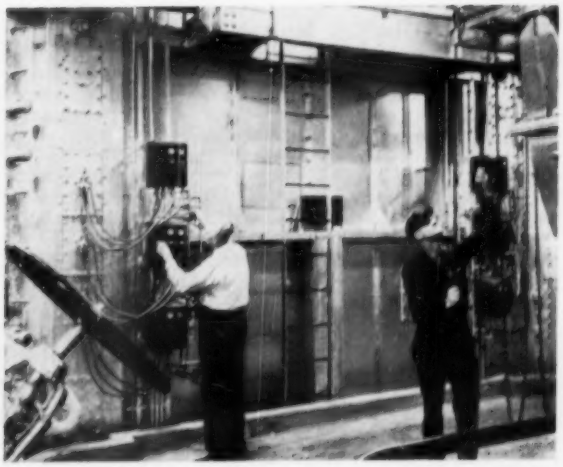


Fig. 4. Another view of new boiler, with Superintendent Oliver and an assistant carrying out routine operations

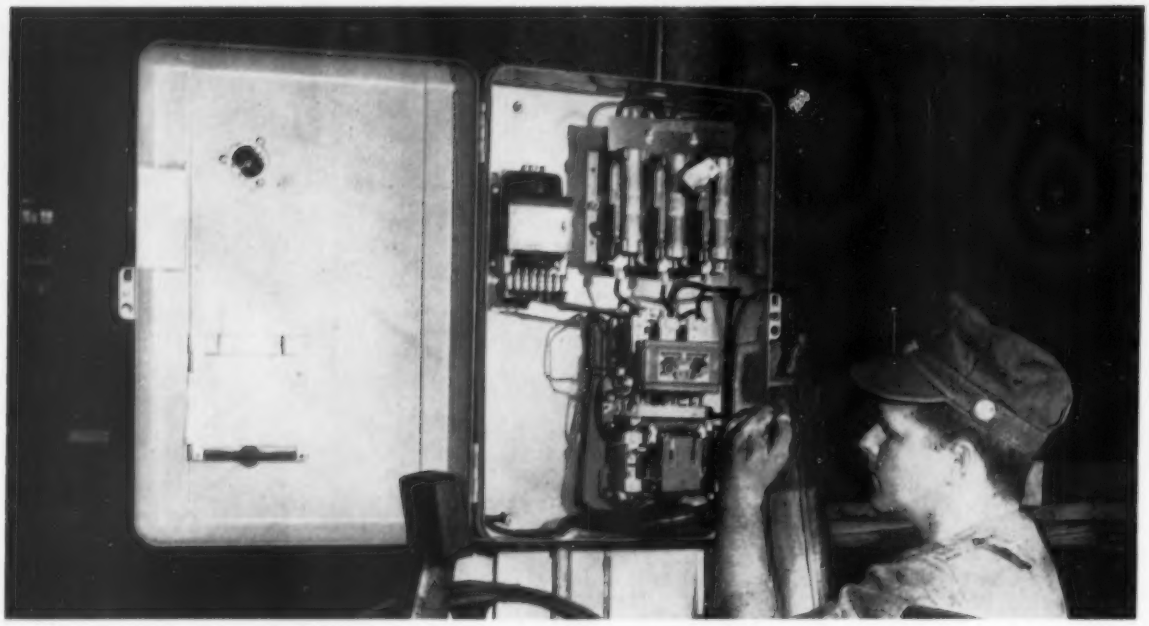


Fig. 1. A typical combination fused magnetic starter for a 10-hp motor. Should one fuse blow, motor could be single-phased

SINGLE-PHASING . . . .

What It Is—What To Do About It

By G. W. HEUMANN*

MOTOR BRANCH-CIRCUIT protection performs two functions: (1) Circuit breakers or fuses protect the branch-circuit against the distructive effects of faults and short circuits; (2) overload relays, usually bimetal or solder-film thermal relays, are used to protect the motor against overheating and possible burn-out due to operating overloads.

Most general-purpose starters for three-phase a-c motors contain two overload relays, connected in two phase lines to the motor starter. On a symmetrical three-phase system, two relays are used to protect the motor against any overload, up to the stall point.

The question arises whether this standard relay set-up will prevent damage to the motor in case the motor branch-circuit is "single-phased." Single-phasing of the power supply to a motor may be caused by conductor breakage or by opening of a protective fuse.

There are no recognized national standards which govern behavior of motors and their heating under single-phased operation. Hence, it is difficult, if not impossible, to predict precisely the behavior of each and every three-phase motor on a single-phased branch-circuit.

Many power distribution systems and the branch-circuits of many large motors are relayed for protection against single-phasing. However, it is not economically feasible to relay each motor branch-circuit in an industrial plant for phase balance, and it has become accepted practice to rely on the thermal overload relays forming part of motor controllers for protecting motors against single-phasing. This article will discuss the risks which are involved when general-purpose industrial three-phase motors, used with standard controllers, are subjected to single-phasing.

Trouble Less Likely In Cities

In metropolitan industrial power systems, conductors are cabled or carried over substantially built overhead lines. Conductor breakage is a rather unlikely occurrence. Also, single-phasing on the primary side of step-down transformers is not to be expected frequently, since such systems are generally protected by circuit breakers. However, feeders to isolated rural or suburban loads are sometimes carried over comparatively weak overhead lines which may be subjected to conductor breakage. Also, such circuits may be protected by fuses which may single-phase the line by blowing only one fuse in cases of faults to ground or line-to-line.

Much more frequent is the single-phasing of low-voltage feeders and motor branch-circuits on the secondary side of the step-down transformer, since fuses are used to a considerable extent for the protection of feeders and motor branch-circuits. Single fuses may open under fault conditions, or they may open on account of aging or environmental deterioration. Modern high-interrupting-capacity fuses contain a silver conductor, and they are not likely to open unless they are melted by current flow. However, there are still many NEC fuses in use which contain zinc-alloy conductors which may age, and corrode, and open-circuit without any current flowing.

Concerning their engineering significance, there are three kinds of single-phasing:

1. Single-phasing the primary of a wye-wye or delta-delta connected step-down transformer;
2. Single-phasing the primary of a wye-delta or delta-wye connected step-down transformer;
3. Single-phasing the motor branch-circuit on the secondary side of the step-down transformer.

*Engineering Planning and Development, General Electric Co.

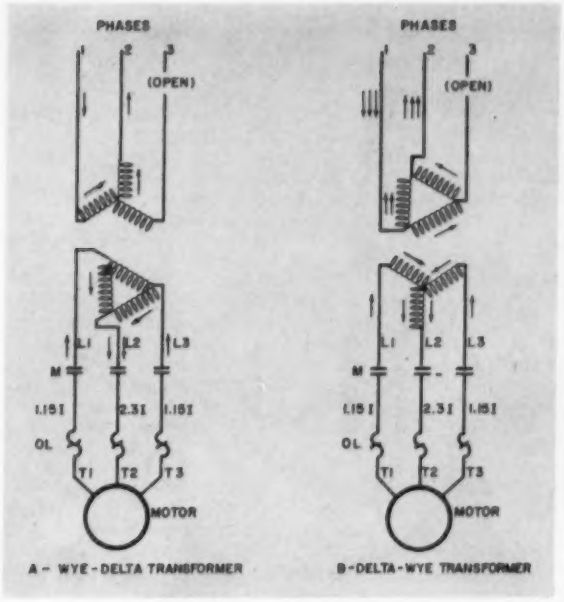


Fig. 2. Effect of loss of one primary phase on motor loads being fed by wye-delta and delta-wye connected transformers

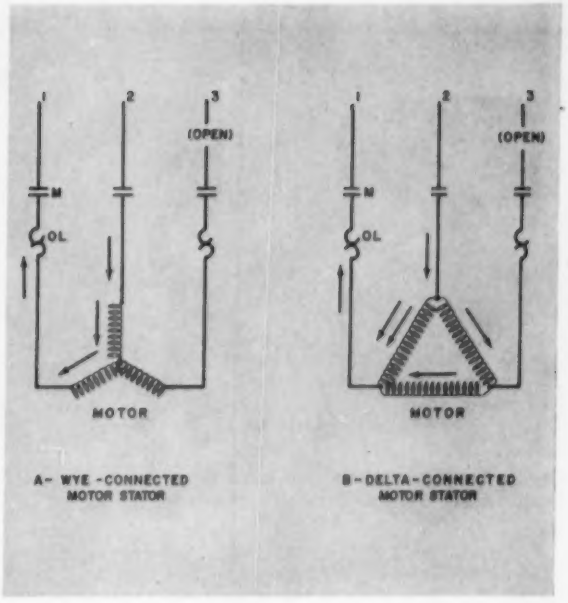


Fig. 3. A schematic diagram of the current distribution in wye- and delta-connected motors under single phase operation

Single-phasing on the primary side of a wye-wye or delta-delta connected step-down transformer has the same result on the secondary voltage system as the loss of a secondary phase, as long as no rotating equipment is running. If some motors are running when the single-phasing of the transformer primary occurs, the running motors may act as phase converters and maintain a fairly well balanced three-phase voltage triangle on the transformer secondary side, especially when the transformer is not fully loaded. Single-phasing of transformer primaries has gone unnoticed for prolonged periods of time because of normal behavior of apparatus.

A different situation exists when the motor branch-circuit is supplied by a transformer having wye-delta or delta-wye connected windings. This condition is illustrated in Fig. 2. View A shows the case of a motor connected to a wye-delta transformer. If one of the primary phases (for example, 3) is open-circuited, current flows in two legs of the primary winding, as indicated by the arrows. The corresponding secondary winding to which the motor is connected is not open-circuited, that is to say, current is flowing in all three lines to the motor but it is unbalanced.

If the letter I represents the current which would flow under balanced conditions, and if no other rotating apparatus were connected to the secondary side of the transformer, the current flow in two of the lines would be 1.15 I, and 2.30 I in the third. Even with other rotating apparatus connected to the transformer secondary, current division may not be such that one line carries exactly twice as much current than the other two, but one line always carries a higher current than the other two lines.

If a standard starter with two overload relays were used, the higher current might flow in the line which was not protected by a relay. Hence, three overload relays, one in each motor phase, should be provided in the starter in order to protect the motor against loss of any transformer primary phase.

A similar situation exists when the motor is connected to a delta-wye transformer as indicated in view B of Fig. 2. Direction and relative magnitude of current flow are indicated by arrows. In this case it is also possible for one line to carry a higher current than that carried in the other two lines.

Two Overload Relays Enough?

Since proper thermal protection against primary single-phasing of wye-delta or delta-wye connected transformers can be accomplished only by the use of an overload relay in each of the three phases, the question has been raised why the industrial control industry has not standardized on the use of three overload relays on standard a-c motor starters, thereby providing motor overload protection under any power system condition. Such a step would raise the cost of all three-phase a-c starters and would penalize users who do not require this degree of protection.

Operating experience indicates that single-phasing of transformer primaries is a comparatively infrequent occurrence, and three overload relays are needed only for a small minority of a-c motor installations. Consequently, Section 4327 of the National Electrical Code recognizes the use of two overload relays as adequate protection of three-phase motors. However, a note in this Section empowers the Authority enforcing the Code to require the use of three overload relays if field experience in the territory of the Authority indicates that primary single-phasing of transformers may cause motor burn-outs when only two relays are employed. For this reason, the industrial control industry offers general-purpose starters with an optional third overload relay.

If the single-phasing on the secondary side of the step-down transformer happens at some point in the distribution system beyond which a number of motors may be running, the same condition may exist as in the case of a primary single-phasing, and the running motors may maintain a reasonably balanced three-phase voltage pattern.

However, if single phasing occurs on a motor branch-circuit, by the opening of one of the protective fuses, for instance, there exists a true single-phase condition, since no other rotating equipment may feed into the branch-circuit. Power to one phase of the motor is definitely interrupted, and the motor acts as if it were connected to a single-phase power supply.

When one line phase to the motor carries no current, the three stator phase windings do not carry the same current, hence they do not contribute evenly to the output of the motor. The following changes take place in the behavior of the motor.

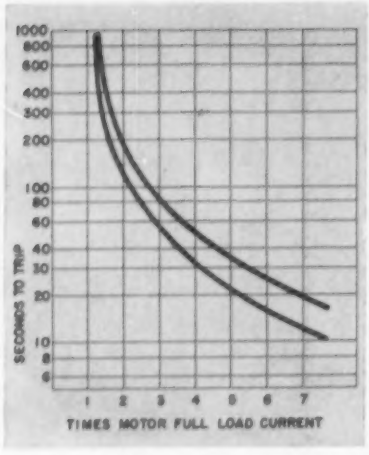


Fig. 4. Band of overload trip currents of NEMA size 2 magnetic motor starter

Running Current: A single-phase motor will not start when single-phase power is applied to its terminals. However, once it has been started, it will keep running on a single-phase supply. Likewise, a three phase motor which is single-phased while it is running will continue to run as a single-phase motor, provided the load torque does not exceed the breakdown torque of the motor. Its slip will be somewhat increased.

If the motor is lightly loaded so that its slip is not increased significantly, the current drawn from the line during single-phase operation is 1.73 times the current drawn during three-phase operation at the same load. However, when the motor operates closer to full load, it runs at higher slip, and the current drawn during single-phase operation is increased. It may run as high as 2.25 times the current drawn during three-phase operation.

Current drawn from the line, which is "seen" by the overload relays, may not determine the actual heating of the motor stator winding. There is a difference between motors with wye- and delta-connected stator windings, as illustrated in Fig. 3. When the stator is wye-connected, only two phases of the stator winding carry current, and that current is equal to the current drawn from the line. Hence, the temperature rise of the operative windings is determined by the same current as is seen by the overload relay in the line.

In the case of a delta-connected stator winding, all three phases carry current, but the current in one phase is approximately twice the current carried in the other two phases. Damage to the motor depends on the hot-spot temperature attained by the winding carrying the higher current. As compared with three-phase operation, the current in the one winding is increased by a ratio of $2/1.73 = 1.15$ as compared with the increase in line current.

For this reason, it is customary for U. S.-built three-phase industrial motors with delta-connected stator windings to be designed with a maximum current density in the stator conductors which is only 0.866 of the limiting current density used in the design of wye-connected motors, unless it is known that other means than thermal overload relays are provided for protecting the motor against single-phasing. Thus, the temperature rise of the most highly loaded winding phase during single-phase operation is not higher than the temperature rise within an equivalent wye-connected stator winding. However, many foreign-built motors use the same limiting current density for wye- and delta-connected motors.

Occasionally, on special and large motors, peculiar designs of rotor windings exhibit greater heating due to negative-sequence currents than would be encountered for positive-sequence current. On such motors the heat generated may be determined by the motor rather than the stator condition during single-phase operation. Such motors cannot be protected by thermal overload relays while running on a single-phased power supply, and they should be treated as a special problem.

Locked-Rotor Current: With the motor at standstill, the locked-rotor impedance per phase does not differ significantly whether the motor is connected to a single-phase or a three-phase supply. Hence, the locked-rotor current drawn from the line during single-phase operation bears a ratio of $1.73/2 = 0.866$ to the locked-rotor current drawn during three-phase operation. Hence, any controller which is capable of interrupting the three-phase locked-rotor current of a given motor should have no difficulty in interrupting its locked-rotor current during single-phase operation.

Breakdown Torque: Motor theory indicates that a single-phase motor is capable of absorbing a power input of approximately one-half the power input of a three-phase motor of equal size. The ratio of power output at the motor shaft is of the same order of magnitude. The breakdown torque of a three-phase motor during single-phase operation can be expected to be between $\frac{1}{2}$ and $\frac{2}{3}$ of the breakdown torque obtained during three-phase operation.

The breakdown torque of NEMA Design B motors, which constitute the bulk of industrial motors, is not less than twice, and for smaller high-speed motors even up to 2.75 times rated motor torque. Hence, the breakdown torque of a single-phased motor can be expected to be equal to or greater than rated full-load torque. Consequently, a motor that is running while single-phasing occurs, and which does not carry an overload, can be expected to continue running and carrying its load.

Standard general-purpose starters are equipped with thermal overload relays which depend on the deflection of a strip of bimetal or the softening of a film of eutectic solder to actuate a contact which trips the starter disconnecting the motor from the line. Line current drawn by the motor flows through a heater which raises the temperature of the bimetal strip or the solder film in such a manner that the relay temperature is a replica of motor temperature.

The inverse-time characteristic of the relay permits the motor to utilize its overload capacity and to carry an overload for a period of time, but it will cause the motor to be taken off the line under a prolonged overload, the intent being that the motor should not exceed the temperature limit on which motor design is based.

Relay design considers the motor heating characteristic so that the relay trips just a short time before the motor reaches its ultimate permissible temperature. Because of manufacturing tolerances and definite steps between relay heaters, the tripping curve of a given starter size is a band delineating a range between upper and lower limits within which the tripping curve of any individual starter with any relay heaters will fall. Figure 4 shows a typical tripping band for a NEMA size 2 starter which is suitable for motors up to 15 hp at 220 v or 25 hp at 440 v. In general, relay heaters selected for larger motors tend toward the upper limit.

Tests Show Relays Adequate

Laboratory tests have shown that thermal overload relays of modern design, when equipped with heaters selected properly from the manufacturers' heater tables, provide overload protection to a running motor. Another condition against which the thermal overload relay is expected to protect the motor is burnout during a stall. When the motor is stalled, there is no cooling by windage, and the motor heats more rapidly than during an overload while running.

Since stalling occurs infrequently, it is permissible to let the motor attain a higher temperature than the rise forming the basis of its rating, but sufficiently low to prevent permanent damage to the insulation. For motors with Class A insulation, a locked-rotor winding temperature of 190 C is considered permissible.

Locked rotor currents of general-purpose squirrel-cage motors are of the order of 6 times rated full-load current. Permissible stall times are generally between 25 and 35 seconds, the trend being for larger motors to have longer stall times. Stall times as low as 20 seconds may be indicated occasionally on small motors, and up to 45 seconds are permissible on some of the larger motors. Tripping characteristics as indicated in Fig. 4 are adequate to protect squirrel-cage motors against burn-out during a stall.

continued on page 100

Fig. 1. Delaware City Station, where insulation has been installed on three 500,000-lb-per-hr boilers by methods described. Tidewater Oil Co's refinery at left

Standardization, Simplification Cut These Boiler Insulation Costs

Details of material and methods that have sped insulation of three 500,000-lb-per-hr boilers at Delaware City Station of Delaware Power & Light Co. Plant will burn fluid coke from adjacent Tidewater Flying A Refinery, supply refinery with process steam and power

By L. DUDLEY BRUCE*

STANDARDIZATION and simplification of both methods and materials were speeding insulation of the three 500,000-lb-per-hr boilers being installed by the Riley Stoker Corp, at the new Delaware City Power Station of the Delaware Power & Light Co. This unusual power station, Fig. 1, will receive fluid coke, a refinery by-product, for fuel from the Tidewater Oil Company's new Delaware Flying A Refinery, which is going up next door. The station, which will serve the refinery primarily, is the first large generating station in this country designed and built for the purpose of using fluid coke as its primary fuel. For ignition, No. 6 fuel oil will be used, and refinery gases will also be burned. Each of the three boilers is delivering steam at 1425 psig, 950 F.

These three turbo-furnace boilers, first in the country constructed especially to burn fluid coke, were placed in service in record time. Much credit for the speed of erection is due to the careful planning of design and procurement of setting details and materials.

Composition of fuel is not the only unusual feature of the new station. Riley engineers have also achieved materials economy and methods simplification as well as top thermal efficiency through modifications of conventional insulating procedures. They have accomplished this through the use of one basic high-temperature insulating material to cover all flat and large curved surfaces on boiler walls, accessory housing and ducts; by simplifying the design of the weather-proof jacket on ducts and housings; by selecting a one-course insulating-finishing cement; and, by shop fabrication and attachment of insulating anchor wires wherever possible.

Mono-Block, a spun mineral wool insulating block, was chosen as the basic insulation for boilers, boiler accessories and duct work. Light, easy and comfortable to handle, the block is designed to be not only capable of withstanding temperatures to 1700 F with high thermal efficiency, but also to be easily and simply applied.

Casing Coat

Preparation of the boiler casing, ducts and housings to receive the insulation is accomplished in the shop. Short lengths of No. 9 gage soft annealed wire are spot welded to the small individual flanged casing panels and to the buckstay channels. Wires to accommodate insulation thicknesses to and including 4-in. are 6 in. long, longer for greater block thicknesses. Welded on staggered 6-in. centers, the wires are allowed to

* Chief Project Engineer, Riley Stoker Corp.

lie flat on the 10-gage steel panels during shipment of panels to the job.

After casing erection, the wires are bent up perpendicular to the surface and the insulating blocks are impaled upon them. Standard size blocks fit snugly in each individual casing panel. Total block thickness on boiler casing ranges 2 to 5½ in. depending upon location. Insulation thicknesses greater than 2 in. are applied in two layers with block joints staggered. Thickness of the base course of block is 2 in. throughout. This corresponds to the depth of the casing panel flanges, thus presenting a smooth uninterrupted surface, flush with flange edges, upon which to apply the second layer. The second layer of block provides additional insulation thickness as required.

Casing Breathes

Boiler settings at Delaware City are completely lagged. Lagging panels of 12-gage steel cover both the insulated casing and the exposed buckstay beams. The setting itself is designed to accommodate thermal expansion and no expansion joints are required in the insulation. To accomplish this, the setting is expandable — it "breathes" — as the water-wall tubes expand and contract. Channels, fixed to both buckstays and water tubes, hold the tubes in alignment and support the sectional casing sheets. These channels — and the buckstays — move with the tubes, and the casing follows.

The lagging is hung in 10-ft vertical sections between the buckstays but is supported by only one of the beams. Each 10-ft section of lagging overlaps the one below. Thus the separate lagging sections move individually, the overlap between them assuring the integrity of the outer shell. The insulation, anchored only to the casing panels and channels, can move freely with them, while being protected from the weather at all times by the lagging.

Before the second layer of Mono-Block is impaled over the first and before the lagging is applied over the second layer, all block joints are pointed with mineral-wool insulating finishing cement to complete the thermal seal.

Housings and Ducts

Housings for auxiliary equipment and all duct surfaces are similarly insulated, except that lack of a metal outer shell calls for another finishing technique. As with the casing, lengths of 9-gage wire are spot welded on staggered 6-in. centers to housing and duct panels during fabrication, and allowed to lie flat during shipment.

After duct assembly, insulating blocks are impaled upon the wires, which have been pried up to receive them. Every other one of the protruding anchor wires are then bent back and pressed into the block to secure them to the surface being insulated. If two layers of block are required, no wires are bent over the first course. The second layer is impaled over the first — joints staggered — and both layers are secured by bending alternate wires. Joints of both layers are pointed with insulating-finishing cement.

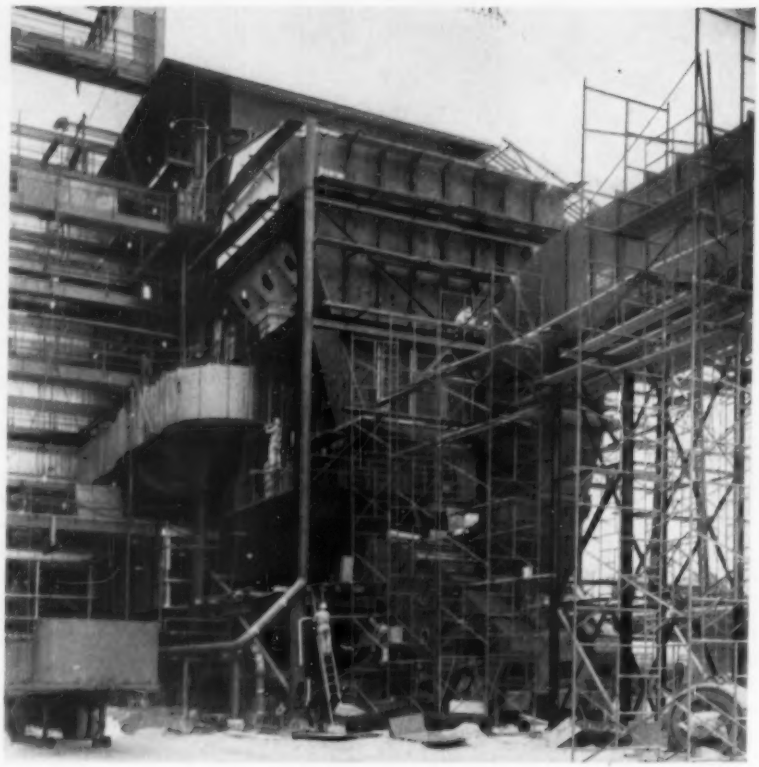


Fig. 2. Rear view of boiler No. 1, showing breeching, induced draft fan and duct to air preheater in various stages of preparation and application of the insulation

Normally, application of wire mesh to all final exterior block surfaces would be the next application step. However, because the bond between the mineral wool cement used, Super Powerhouse Cement, and the Mono-Block has such inherent strength — even greater than the tensile strength of the block itself — wire mesh reinforcing is not considered necessary. However, on overhanging surfaces, wire mesh is applied to provide additional support to the hanging blocks. The mesh is tied tightly to the undersides of ducts and housings by the tire wires which have been left extended for the purpose.

Next, duct and housing flanges and stiffeners, which interrupt and protrude above the outer block surface, are covered with half-sections of molded pipe covering secured with wires tied to the original anchor wires; and plasterers' corner bead is fastened to all edges.

On top horizontal and all vertical surfaces, a single ⅜-in. course of white Super Powerhouse Cement is applied directly over the block without mechanical reinforcing. On undersurfaces it is applied over the mesh. The cement is rough troweled and brushed with water before drying, to insure a rough surface for applications of weather-proof coating.

Simple Weatherproofing

Weatherproofing methods at Delaware City are much simpler, require fewer materials than conventionally specified. The wire mesh mechanical diaphragm is applied over the insulating-finishing cement on all surfaces and is secured by the alternate-welded anchor wires, which have been allowed to extend through the single course of cement. The mesh girdle thus not only supports the insulation as well as if it were applied beneath the cement, but it is in a position to also reinforce the mastic weatherproofing. As a result, need for a fabric material, as well as the mastic tack coat to adhere it, is eliminated. A single application of asphaltic mastic weatherproofing, sprayed on at a rate of 7 gal per 100 sq ft, is all that's needed to complete the weather barrier.

Opposite Page Shows How They Applied the Insulation

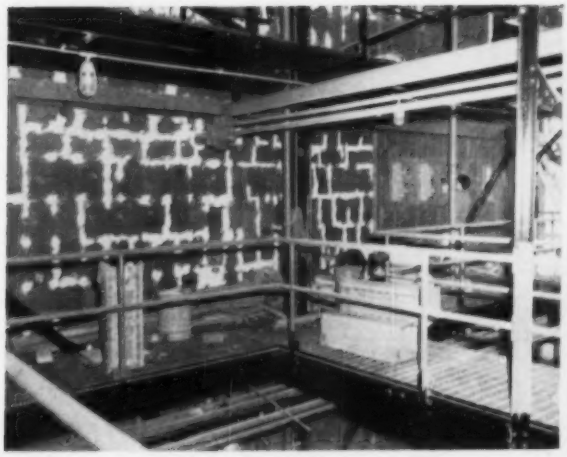


Fig. 3. View of insulated boiler water-walls. First layer of insulating block has been applied, joints pointed. At right, second layer of block has also been attached, as told in text

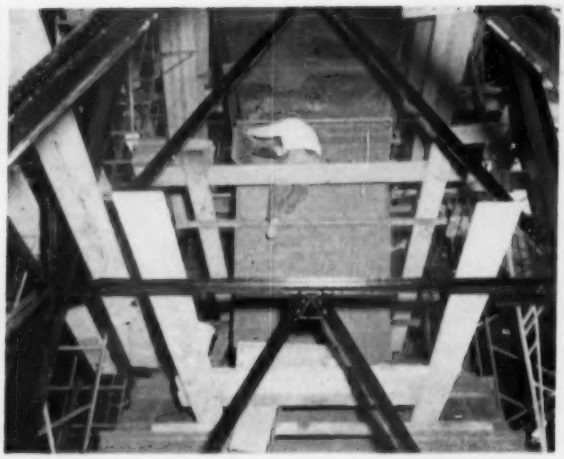


Fig. 4. Workman cuts mineral wool block to fit breeching between boiler and induced draft fan. This is a detail from the general view of Fig. 2, which shows rear of boiler No. 1

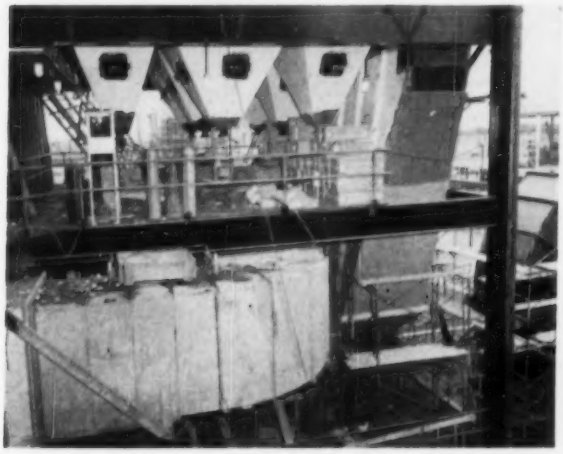


Fig. 5. Both block and mineral wool insulating-finishing-cement have been applied to dust collector hoppers. At right, partial insulation of gas duct. Lower left, hot air duct ready

Fig. 6. Workman applying mineral wool block to casing in two layers just above boiler skirt. (He isn't too uncomfortable for a cigarette). Note how block conforms to bend in casing

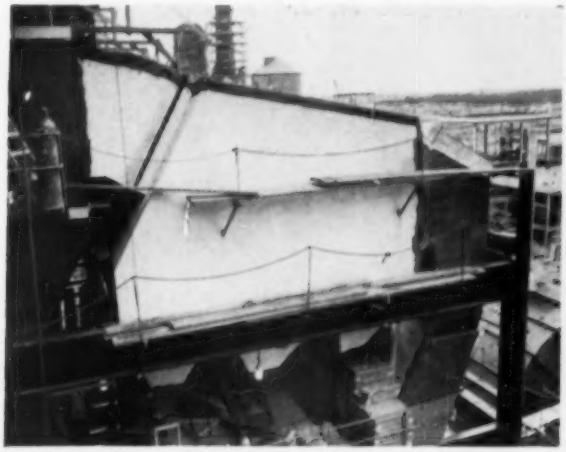


Fig. 7. Block insulation on dust collector is covered with mineral-wool-insulating-finishing cement. Weatherproof paper protects top surface not yet permanently weatherproofed

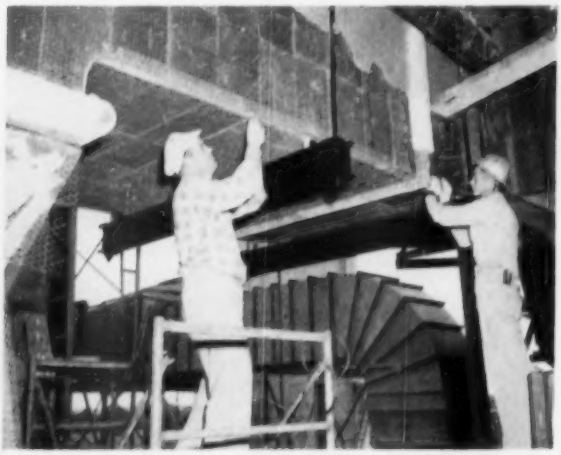


Fig. 8. Duct insulation, showing half of wire studs still protruding from block. Wire mesh over block only on underside. Half section of molded pipe covering on duct stiffener

Fig. 1. Coal tower on Ohio River can handle 1200 tons/hr; equipment includes progressive reeving system described here

New Reeving System Triples Life Of Coal Tower Wire Rope

By F. O. SNOW, Jr.*

ONE OF THE PROBLEMS in the operation of coal unloading towers is wire rope replacement. Replacement expense involves not only the actual cost of the rope, but also the value of the unloading time lost while the tower is laid up for the removal of worn rope and the reeving of the new, plus the labor required to accomplish this task by pulling the rope through the system by hand.

A new progressive rope reeving system has been specifically developed to extend the life of the rope used for closing and hoisting and to reduce the downtime and amount of labor and number of personnel required to reeve new rope into the tower system. Figures recently made available by a close study of this system in one particular field operation have proved the economies anticipated by the engineers responsible for its development.

A study of the operation of three modern coal unloading towers equipped with conventional reeving systems has shown that 585 ft of closing rope wore out after handling 58,900 tons of material, and 444 ft of holding rope lasted through 77,900 tons. Therefore, the average rope life of this system is 0.01563 ft of rope per ton of material handled, or an average of 64 tons of material handled per ft of rope.

Experience with the progressive reeving system has shown that most economical operation is obtained by feeding into the system 140 ft of rope for every 30,000 tons of coal unloaded. Thus an average of 214 tons per foot of rope is unloaded with the same standard wire rope that gives only 64 tons per ft when used in similar service in conventional systems. In addition, only two men, the operator and helper normally assigned to the tower, are all that are required to make the changes in the rope system. This is in contrast to the six men normally required to replace rope in older systems, four of whom must be taken from other productive work to assist the operator and his helper.

With the new method, only one shutdown is required to replace line that is used for both hoisting and closing. With older reeving systems, it is seldom, if ever, that both lines wear out at the same time, thus requiring longer shutdown time for replacement of the wire rope. These savings — more than threefold extension of rope life, one-third replacement labor, and less total shutdown time — are the result of the new reeving system.

In any rope system the points of wear will occur where the rope runs over sheaves, rollers, and drums. When wear occurs in these rope areas on older systems, the entire length of rope has to be replaced with new rope. A considerable amount of this rope remains in good condition but has to be discarded along with the worn portions. The new method provides for progressively feeding new rope into the system in small increments and removing equivalent lengths of worn rope. This distributes the wear evenly throughout the entire length of rope and does away with the necessity of replacing a complete holding or closing rope when only a small part of the rope is worn out. A marked increase in rope life is realized over the two-rope systems used heretofore. If a segment of the

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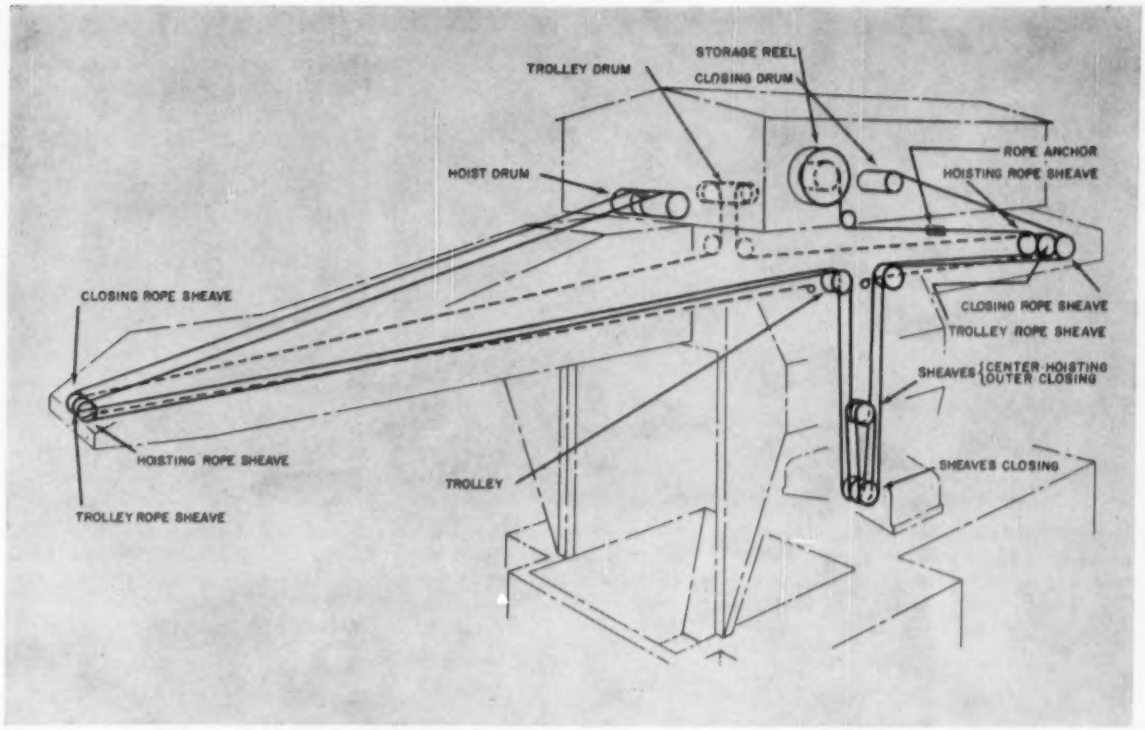


Fig. 2. Diagrammatic illustration of the method employed in the progressive rope reeving system developed by Mead-Morrison

rope becomes damaged, sufficient rope can be pulled out and the damaged section cut off, eliminating the necessity of reeving an entirely new length of rope.

In the progressive reeving system, wear is spread evenly along the entire length of the rope by periodically shifting the point of maximum wear. In addition, one continuous rope is utilized for both the hoisting and closing motions of the grab bucket instead of two separate ropes used in older systems. The new system retains all the features of independent operation of the hoisting, closing and trolley motions of the grab bucket. The hoist drum has been redesigned to include a reeving sheave. A rope storage reel has been added from which rope may be fed into the system as needed.

The rope reeving for the new system is shown in diagrammatic form in Fig. 2. The rope from the storage reel leads through a rope anchor, where it is clamped, around a sheave at the inner end of the trolley runway, over a sheave in the trolley, down to the hoisting sheave in the bucket, up over another sheave in the trolley, out over a sheave at the outer end of the trolley runway, and into the hoist drum. At the hoist drum, the rope passes around a sheave inside the drum where it is clamped as shown in Fig. 3 (A). From the hoist drum, rope travels around a sheave at the outer end of the trolley runway, in over a sheave in the trolley, down and around the closing sheaves in the bucket, up over a sheave in the trolley, around a sheave at the inner end of the trolley runway and to the closing drum where the rope is again clamped.

The operation of progressively feeding new rope into the system is very simple. The hoist drum is turned to the reeving position as shown in Fig. 3 (B), with all rope paid off the drum and the reeving sheave in the drum in line with the ropes leading to the hoisting and closing rope sheaves at the outer end of the troiley runway. The rope clamp on the reeving sheave and the rope anchor near the storage reel are released. The closing drum is rotated to pull out of the system the length of worn or damaged rope to be replaced. The rope is cut off at this point, removed from the closing drum and discarded.

The new end of the rope is then clamped to the closing drum. The same length of rope as discarded is payed off from the rope storage reel through the rope anchor and into the system. The rope anchor is then tightened. At the hoist drum, the same length of rope as discarded is pulled through the sheave in the drum, and the rope clamp tightened. When the rope is rewound on the hoist drum, the rig is again ready for operation. To facilitate this operation, the hoisting and closing machines are both provided with inching control to provide slower rotation of the drums, and the rope storage reel is power driven to reel in or pay out rope.

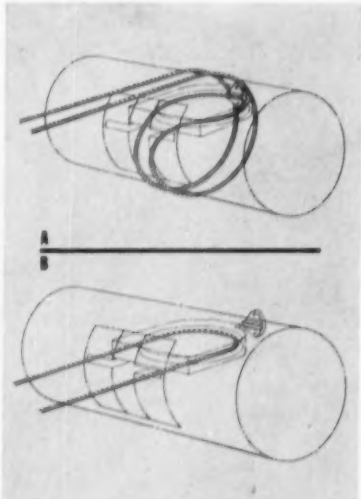
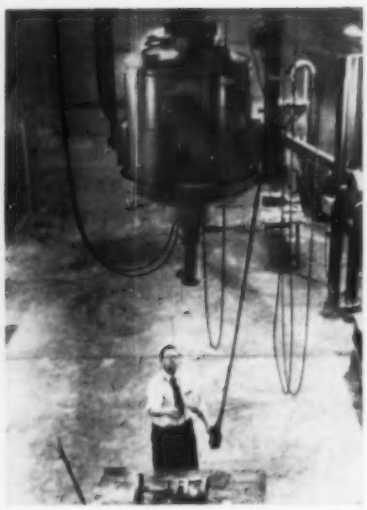


Fig. 3. Schematic diagram of the cable drum used in this system. View A shows cable clamped on sheave; view B shows drum unwound, clamp loose, for reeving

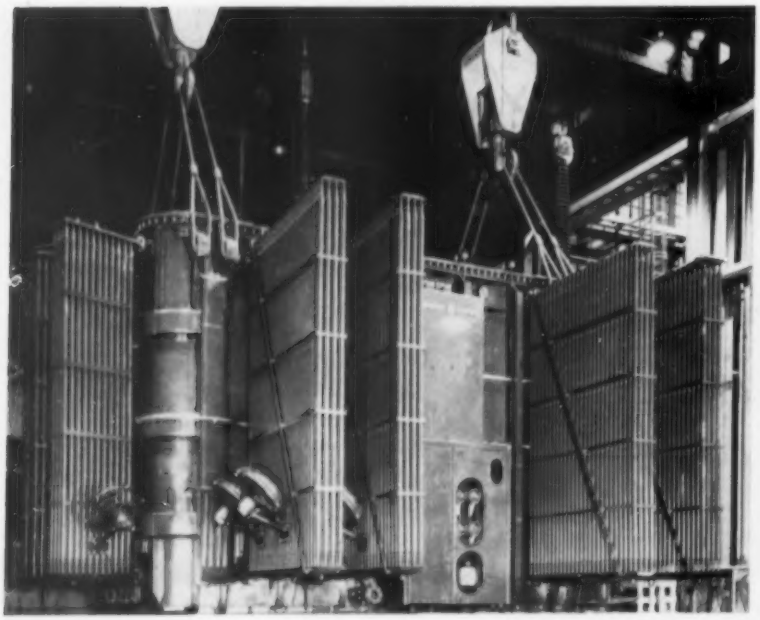
To sum up, Mead-Morrison's new progressive rope reeving system retains the desirable features of the older two-rope system, simplifies the work of replacing rope, and by using the rope more efficiently gives a much longer rope life.

Forces that bind atoms together are studied by Westinghouse scientists in tensile-strength tests of metal "whiskers." Whiskers are growth of highly pure, perfect metal crystals; 0.00004-in. thick—1/100 the diameter of human hair—these strands of pure crystals will point way to new and better alloys



More research—this 1,000,000-v x-ray machine in lead-sheathed lab at International Harvester is a $42,000 investment in knowledge for the future

POWER ENGINEERING'S NEWS REEL

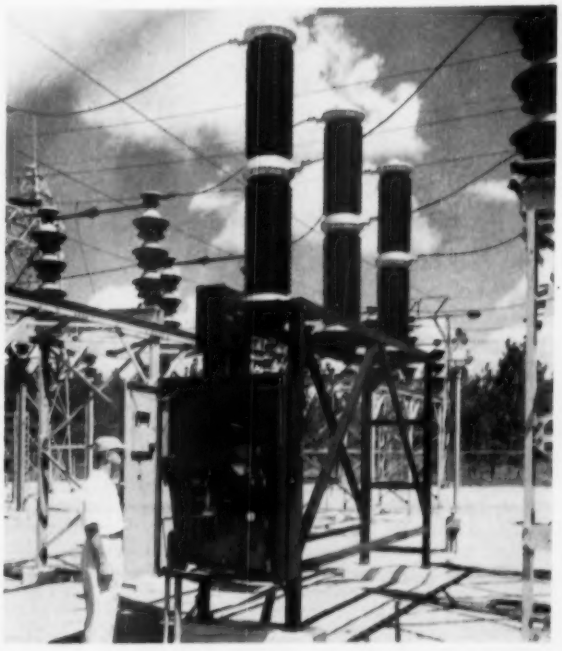


Big autotransformer for Northwest, last of six built by the General Electric Co. for Bonneville Power Administration, is hoisted from test bay at plant. These are single-phase units rated at 200,000 kva; each weighs 205 tons

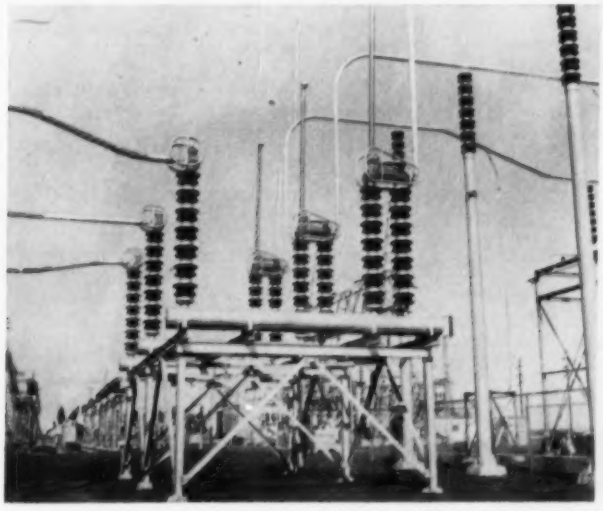
Automation trend in power field is exemplified in new 125,000-kw plant of Jersey Central P&L Co. at Sayreville. Penn Instrument Div.'s controls and recorders transmit both electrically and pneumatically to control room, and are duplicated in plant. Instrument men use walkie-talkie to check readings

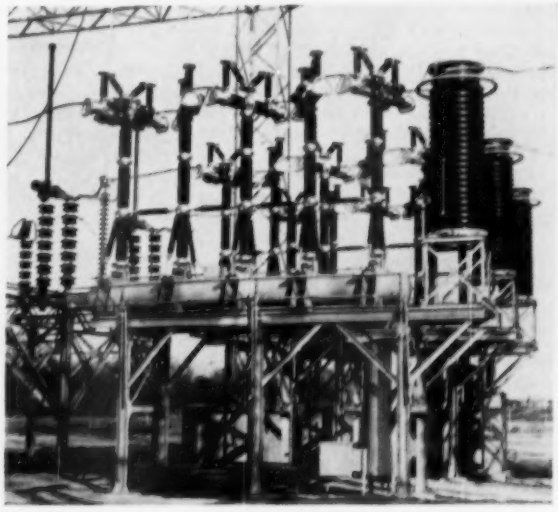
Army Package Power Reactor nears completion as workmen lower 31,600-lb reactor vessel into vapor container at Fort Belvoir, Va. Built by Alco Products, this 2000-kw pressurized-water nuclear power plant will start up in 1957

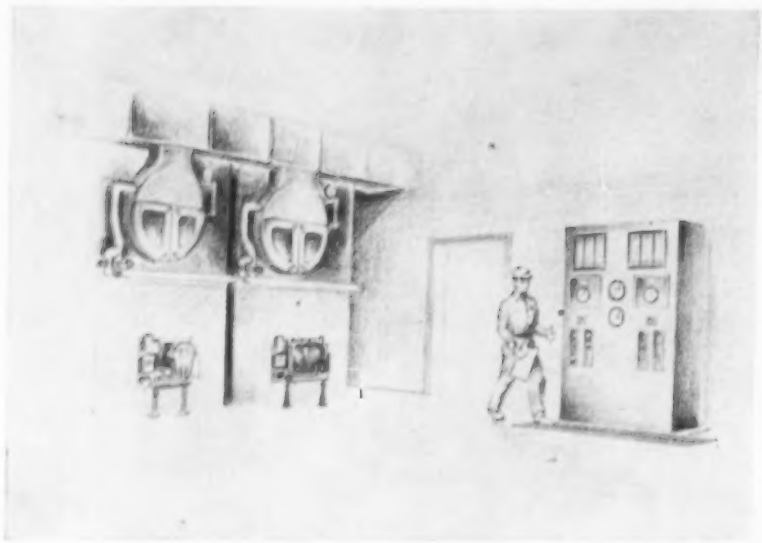
Nearest thing to true Sky Hook is this "Skylift" truck at Con Edison's Hudson Ave. Station on New York's East River. It is used here to help workmen recable booms that support oil hoses at 11,000,000-gal. oil storage facilities



Circuit breaker season is here! At any rate, that's the way it looks from here. At right is first of new type by Westinghouse that uses sulfur hexafluoride gas to quench arc; experimental installation is at Gulf Power station in Florida. Below, right, is 330-kv air blast circuit breaker at Lima plant of Ohio Power; made by Brown Boveri, it is one of largest. Below, Federal Pacific's 345-kv units in Oregon; ratings are: 1600 amp continuous, 70,000 momentary







Can you equip your boiler plant with automatic controls so it will operate safely and require inspection only every hour, servicing every four months?

How Much Attendance Do Industrial Boiler Plants Need?

Fuels burned in suspension create possibilities in the automatic operation of boiler plants that have not yet obtained general recognition by insurance companies and regulatory authorities. Full discussion is advisable so that standards may be set for safety and for realizing the full economies offered by this equipment today

By HENRY D. FISHER, M.E.*

POWER ENGINEERS are often asked a question by business managers, who have occasion to observe the operation of the oil-fired boilers in their residences or the larger units in apartment houses and office buildings, which are only looked at from time to time by the janitors or others responsible for their operation. The question is: "Why is continuous attendance required in the boiler plants of our factories when the equipment installed in them is so similar, except for size, to that in the domestic heating units?"

Usual answers to this question are the traditional ones:

a — Leaving high-pressure boilers unattended creates too great a hazard;
b — Continuous attendance is strongly recommended if not required by the Boiler Codes;
c — Boiler insurance companies dislike the practice;
d — In cities and states having licensing laws for engineers and firemen, continuous attendance is required.

Tradition should not be disregarded simply as old-fashioned, because tradition embodies the results of past experience when many things were learned the hard way. But there are times, when conditions have materially changed, when it is reasonable to review the situation and decide whether some of the prohibitions which have come down to us are still as valid as they once were. One such set of changes is the much more general use of oil and gas as fuel and the automatic controls and safety devices which have been developed for use with these fuels.

Boiler Classification

Now ASME boiler code classifies boilers as "heating" and "power" boilers, the dividing line being at 15 psig operating pressure. When this classification was established it was a simple and logical arrangement for it had not been so long since that every factory requiring power, no matter how small, had its own engine driving a line-shaft system and a small d-c generator for lights. Since satisfactory engine operation required a pressure of 70 psi or greater there was practically no field for units designed for pressures between this and the low pressures adequate for the heating systems of those days which were of moderate size and compact usually in multi-story buildings and could be operated ordinarily at five psi pressure or at less pressure when vacuum return pumps are used.

The heating boiler and its system had three other characteristics not mentioned in the codes but implicit in the whole setup:

a — Condensate returned by gravity;
b — Makeup requirements were usually quite small and could be supplied by city water pressure;
c — Rates of combustion, of evaporation and fire box temperatures were quite low.

Thus it was obviously adequate for no more attendance to be required than could be given by the man whose duty it was to mend the fire as needed and keep up the heat.

On the other hand the power boiler was usually hand fired or equipped with a stoker which required frequent adjustment for efficient operation, so there was no question regarding attendance, although in many of the smaller plants the operator not only fired the boiler but ran the engine and wheeled coal and ashes. Most engines ran non-condensing so that, even if the exhaust was used in the factory heating system the condensate was not returned automatically

* Consulting Engineer, Westcott & Mapes, Inc.

and city water system pressures were low, seldom above 30 psi. So the steam-driven duplex boiler feed pumps were usually run on the throttle and the plant got along with a minimum of regulators and control equipment.

As long as a boiler is fired by a bed of solid fuel a dependable source of feedwater is an absolute necessity; but with the coming of fuels burned in suspension there is an alternate means of preventing boiler damage if the regular supply of feedwater is interrupted. That is to cut off the fuel supply. With no further development of heat in the furnace, temperatures rapidly fall below the danger point, and, with suitable alarm devices, an attendant can be summoned at once.

Purchased Power Increase

Along with the shift to oil and gas fuel has come the change-over to purchased power. Both of these are exemplified by statistics presented at the 1952 ASME Annual Meeting which show the changes between 1938 and 1952 in consumption by industry of the following items:

Bituminous Coal	+ 41%
Purchased electric power	+205%
Oil fuel	+208%
Industrial gas fuel	+187%

With present-day levels of equipment costs and wages, even by-product power must be generated in rather large blocks to make installation of power-generating equipment attractive.

During the period when industry power was largely self-generated, the boiler plant steam pressure was usually as high as the state of the art, the size of the equipment and the supervision available made feasible. When power generation was discontinued the principal requirement for high-pressure steam was for process work. This might be at any pressure from the heating pressure range up; also, steam was usually required in much smaller amounts than for power generation. Such a circumstance tends to close the former rather wide gap between heating and power boilers with an intermediate zone, in which the characteristics and requirements of one class shade into those of the other.

For example, consider the oil or gas fired boiler supplying steam for factory process use and heating. If the boiler is equipped with control and safety devices like those on domestic heating equipment, an alarm system and emergency feedwater supply, it should be classified for operating requirements as a heating boiler. Naturally, it is assumed that such a classification would take into account boiler size and pressure considered safe for that particular installation. It follows that classification as a heating boiler would permit operation with periodic attendance and inspection.

This proposal is a special case and only indirectly involved in the current argument in the letter columns of the power magazines.† Undoubtedly the advocates of two or more firemen can cite instances with serious results, where the single operator was incapacitated. On the other side, mishaps, such as burning up a set of boiler tubes, have occurred where there were two or more firemen on duty. During a discussion on this subject with a Chief I knew well, he remarked "Many times the fireman has nothing to do; then there are times when you wouldn't be able to get all the men you need into the plant." I should say that the attendance required in any plant is an individual problem, based on its equipment and operating cycle, and there is no general solution covering all cases.

For the case under discussion, we have provided inanimate watchers, which, if abnormal conditions occur, take action to prevent danger, and call for help. In discussing this particular problem with the regional supervisor of one of the larger boiler insurance companies, he said that one of their worst problems was neglect of automatic controls and safety devices. Ordinarily, higher management does not concern itself with questions of this sort as long as service is maintained. But with the system of record keeping and the financial incentive for maintaining the system in successful operation there is a much better prospect of effective supervision.

Typical Case

To make more specific the proposition of what boiler plants may be safely operated with periodic attendance, let us set tentatively a pressure limit at 125 psig and capacity, that is, actual maximum output, at 15,000 lb of steam per hour when installed in a separate building, these limits to be increased if further experience is favorable.

Boilers should be fired with oil or other fuel burned in suspension, the supply of which can be interrupted instantly. In addition to control equipment for adjusting the rate of firing to the steam demand, the burners and boilers should have the following safety devices as applicable:

a — Flame-failure control
b — Low gas-pressure switch
c — Low oil-temperature interlock
d — Feedwater regulator
e — Low-water cutoff
f — High-steam-pressure cutoff

Functioning of any of these devices except the feedwater regulator should shut off the fuel supply (and pilot gas for oil burners), sound an alarm, and keep the firing system locked out until manually re-started.

If there is a dependable local water supply at a pressure at least 15 lb above the safety-valve popping pressure, this shall be considered satisfactory for boiler feed supply. If not, duplicate boiler feed pumps, operated preferably by separate power sources such as steam and electricity, and started automatically by a drop in feed line pressure below a fixed differential from the steam pressure, shall be installed.

The boiler installation shall be visited and inspected by the attendant at suitable intervals, probably hourly, these to be recorded on a time clock. At the beginning of each 8-hr shift, or at start and end of day for single-shift operation, the attendant shall check: 1, the flame failure control by inserting a card in front of the electric eye tube and 2, the low water cut-off by blowing down the cut-off float bowl, and shall initial the corresponding spaces in the boiler-room log sheet.

Servicing Schedule

A schedule shall be set up for inspection and servicing of all safety devices. This would include:

a — Checking all wiring for grounds;
b — Testing tightness of wiring connections;
c — Trying contactors, switches and relays for smoothness and proper meeting of contacts, freedom of working and absence of friction;
d — Cleaning all enclosures of dust and dirt;
e — Noting work done and conditions found in log book;
f — Review hours of service of photo-electric cells of electric eye devices and replace tubes in advance of end of expected life.

Inspection of this sort would be made at intervals of four months. If experience showed that little or no servicing was required, the interval could be increased to 6 months and ultimately to one year.

As stated in the first paragraph, this is a live subject and it deserves careful consideration by engineers, insurance companies and regulatory authorities in order that some logical, safe and practical procedure be developed for operating installations without needless expense for attendance.

"If you think that's big, wait till you see the generator. That's just the exciter."

† See POWER ENGINEERING, January 1957, page 6.

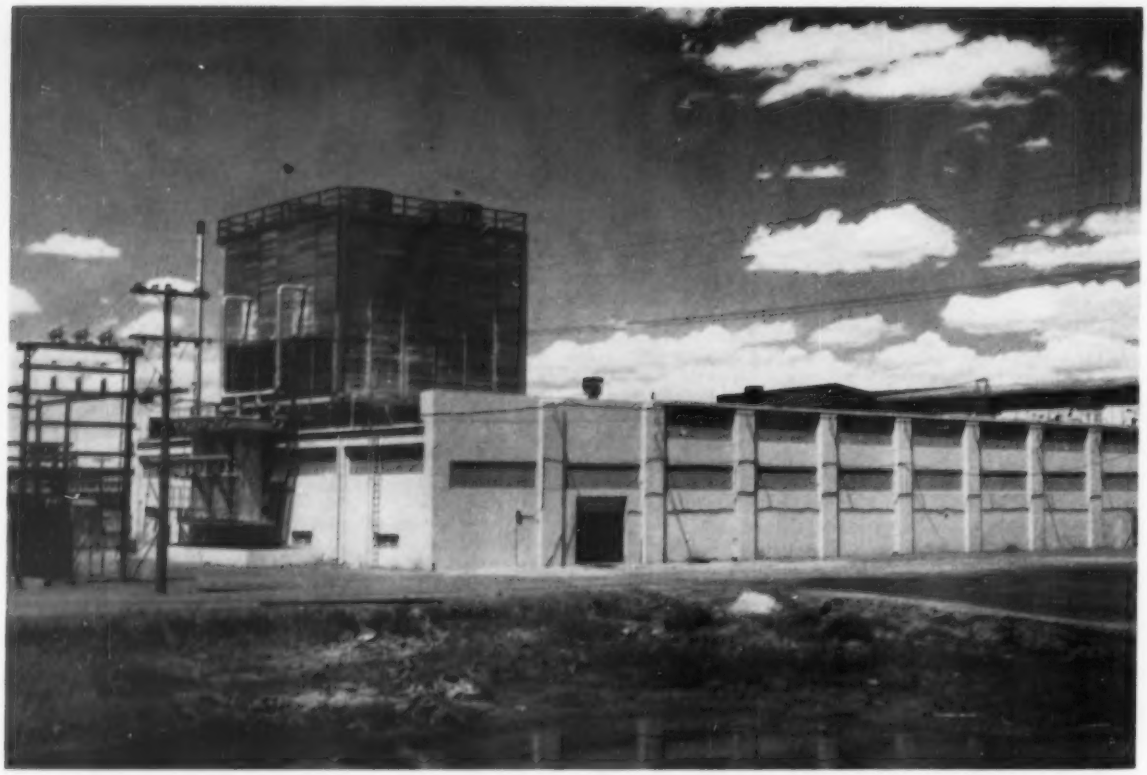


Fig. 1. Compressor and freezing tank room of automatic ice plant. Concrete building has glass blocks instead of windows

Laramie Ice Plant Goes Automatic

PACIFIC FRUIT Express Company, owned jointly by the Southern Pacific and Union Pacific Railroads, operates some 37,000 railroad refrigerator cars to serve the loading requirements of the perishable shipping areas of those railroads. It also operates 15 ice manufacturing plants on the lines of those railroads to provide refrigeration as and when required.

Laramie, Wyoming, located on the Union Pacific Railroad, has long been a very important re-icing station for shipments in transit. Until 1953 it operated with natural ice produced each winter in a pond adjacent to the ice storage facilities.

Change from a natural ice plant, which harvested and stored up to 90,000 tons of ice each season, to an automatically controlled artificial ice plant of 420 tons daily capacity was taken in one step at the Laramie car icing station.

This station is located in the Rocky Mountains at an altitude of 7151 ft. Due to the severe winters and high winds the compressor and freezing tank room were constructed from reinforced concrete and glass blocks without windows (see Fig. 1). The old ice storage of frame construction, size 107 ft × 960 ft with 34 ft ceiling was re-insulated and equipped with refrigerating coils for proper preservation of ice.

Refrigeration for the manufacture of ice is supplied by 3 vertical, 4-cylinder compressors, size 11 in. × 10 in., directly connected to 300 hp synchronous motors at 360 rpm and one 2-cylinder compressor, same size with 150 hp motor. Refrigeration for the storage room is supplied by one 2-cylinder compressor, size 10 in. × 10 in., with 100 hp motor (see Fig. 2). Each compressor is equipped with automatic unloading devices for automatic starting and they also have high pressure and low pressure cut-outs.

The metal clad switchboard receives power at 2300 v and steps it down to 440 v through an enclosed air cooled transformer for the auxiliaries (see Fig. 3).

Cooling water is supplied by a Santa Fe four stack, induced draft, cooling tower with a capacity of 3000 gpm. Each stack is equipped with a 10 ft fan which can be driven at full speed (313 rpm), half speed, or reversed to prevent icing in extreme cold weather. Water is circulated by 3 vertical turbine type pumps of 1000 gpm each through vertical shell and tube ammonia condensers shown in Fig. 1.

Ice is frozen in 2 tanks which contain 1872 ice cans of 300 lb each, arranged in 52 rows, 36 cans wide. Each tank has 37 rows of single pass coils which are connected to a 12 in. liquid header at bottom of tank and a 20 in. gas header at top of tank, both headers located at center of tank.

The amount of refrigerant in the coils is maintained constant, whether operating at full or reduced capacity, by liquid level controls located on the tanks and liquid receivers. This gives a temperature difference of not more than two degrees between refrigerant and brine. Ice is harvested 36 cakes per pull and dumped on a cross conveyor which feeds it into the storage room, one cake at a time, where they are transferred on rubber belts to icing platform or winter storage without the need of handling by workmen.

One man, per shift, does the harvesting and has produced over 500 tons daily. Power to the cranes is controlled by electric timers which control the number of pulls made per hour. Recording devices maintain

additional checks on the rate of harvest so that the refrigeration load can be kept constant.

Designed for automatic operation, the plant is supervised by one operator on the day shift, who also performs most of the inside maintenance. When set for automatic, and the temperatures are high enough to require refrigeration, the circulating pumps start first, then the cooling tower fans and brine agitators, next the individual exciter for the first compressor motor; the direct current then opens the unloader valve on the compressor and closes the oil switch on the motor. Excitation is applied when the motor reaches the proper speed and time delay relays open the solenoid stop valve and closes the unloader. Timer relays then start the other compressors at proper intervals to protect the electrical system from overload.

The temperature control device will maintain the brine temperature in the ice tank, within $\frac{1}{2}$ degree of the desired temperature, whether operating at reduced or full capacity, and has proven its reliability over a period of four years. Compressed air is the slave of the electronic control; opening and closing switches and valves, modulating the flow of liquids and gases as directed.

To make it possible for 1 man to satisfactorily supervise a plant of this size a central temperature indicating panel is placed at his desk where, by a selector switch, he may at a glance check the temperature at 22 thermocouples strategically placed in the refrigeration system. In addition, circular chart recorders provide a permanent record of all important temperatures and pressures within the system.

Perhaps a word about the use of the manufactured product is in order. The car icing station is a point where railroad refrigerator cars are supplied with ice to furnish the necessary refrigeration. The icing platform is 4,840 ft long and accommodates 110 cars on each side. Ice is conveyed the entire length of the platform by chain conveyors which are divided into sections of approximately fifteen car lengths. The car bunkers are filled by newly developed machines, traveling on rails located on top of the platform.

These machines pick up the ice cakes from the conveyors, crush it to the desired size and drop it into the bunkers. One of these machines is illustrated in Fig. 4. Each one can handle 12,000 lb of ice per min, and is operated by one man. Each machine is equipped with 2-way radio for maintaining close supervision. The unique feature of this operation is the supervisory control system which permits any machine operator to stop, start or reverse any of the conveyors from his machine while in motion, through a single overhead trolley wire. Three of these machines operating together consistently ice 100 car trains in 35 minutes.

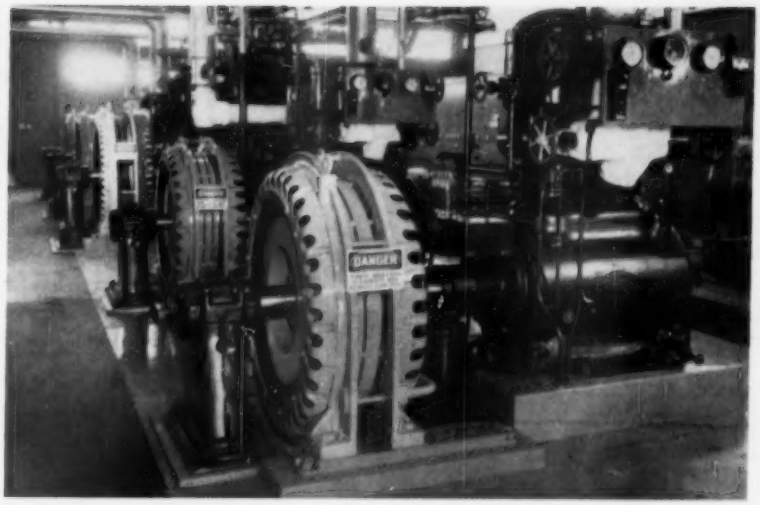


Fig. 2. Compressor room. Each machine has thermal cutout protection against overheating, and pressure switch protection against lubricating oil pressure failure

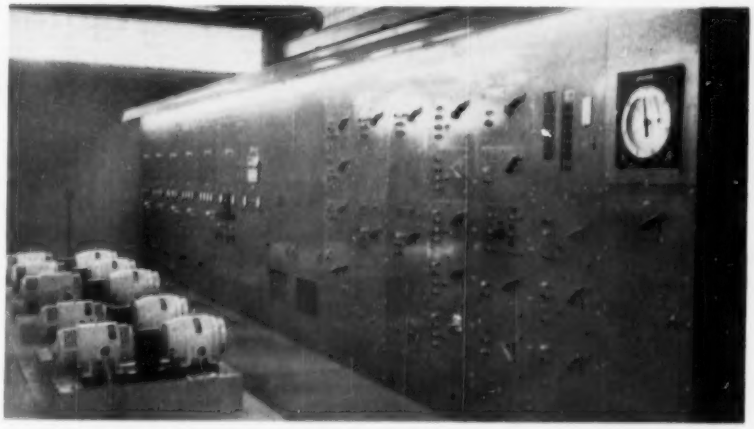


Fig. 3. Main switchboard for the ice plant, with automatic controls for each piece of equipment. Panel at the extreme right controls all automatic operations

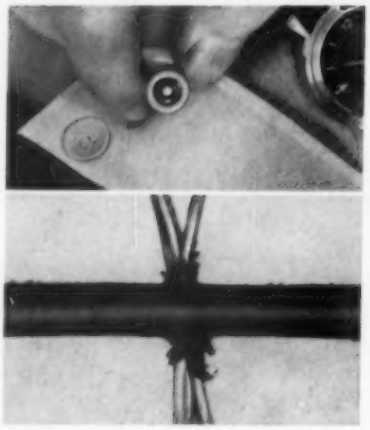
Fig. 4. Railroad car being filled with ice by newly developed machines at car icing station. Three of these machines together can ice 100 car trains in 35 min

Know Watthour It Is? New Electric Watch Will Always Give You Current Time

SO FAR AS WE KNOW, none of our readers have yet been faced with the complexities of a new development in the field of power engineering — the electric wrist watch. Such a timepiece has actually been announced by the Hamilton Watch Co, and we expect you'll be hearing about it — in some detail — from your favorite radio and TV announcers.

Normally, watches are a little out of our line, but when they start powering the things with electric motors — well, maybe we had better review our editorial policy.

Power for the new watch comes from a small disk-like unit which the advertising boys call an Energizer; we suspect that you might call it a battery cell. But whatever you call it, it will drive the watch mechanism for more than a year, which is pretty good performance at that for a unit no bigger around than a shirt cuff button.



Power for new electric watch comes from tiny disk unit compared with shirt cuff button (top); below, three coil wires pass through hole bored in human hair

Additional components of this Lilliputian power plant are a permanent magnet weighing 0.0056 oz and a coil wound with wire only one-fifth the thickness of a human hair. The picture shows three strands of this wire (0.0006 in. each) threaded through a hole in a strand of hair. (Maybe we're doing an injustice to the craftsman who did the job, but isn't that a pretty ragged hole? Last shop *we* worked in, it would never have gotten by Inspection.)

[*Editor's Note: Hah! At the last boiler factory* he *worked in, they had to call in outside help to drill anything smaller than a half-inch*]

One feature of this new watch is of definite interest to power engineers. The makers claim that it is more nearly free from disturbance by stray magnetic fields than any other watch. (And just think, no more tedious, laborious winding day after day.)

Fixed-Pipe Extinguisher Kills Transformer Top Fire

WHEN PROVIDING fire protection for transformers, it is easy to overlook the fact that mobile extinguishing equipment may not be able to reach a fire that might occur on top of the transformer.

This danger was very effectively demonstrated recently at Commonwealth Edison Company's Ridgeland Station before delegates to the National Safety Congress in Chicago.

The shell of one of the utility's scrapped 10,000 kva transformers was used for the display. The idea was to start fires on top of this transformer and then compare the performance of a portable extinguisher and a fixed pipe system in putting them out.

Oil and gasoline were first mixed in a shallow pan on top of the transformer. Then an asbestos wick soaked in gasoline was set ablaze, and it in turn was used to ignite the fuel in the pan. The flames were fed by preheated oil pumped to the top of the transformer, and the blaze was helped by an 8 mph wind. The fire soon spread to the transformer cover and licked down the sides.

The fire was allowed to build up for 3 minutes and 43 seconds, and then 16-nozzle fixed dry chemical extinguishing system on top of the transformer was put into action. The fire was extinguished in a few seconds.

Then a wheeled chemical extinguisher was made ready and the fire was started again. After a preburn of more than 3 minutes, the extinguisher was brought into action. Wherever the dry chemical blanket struck, fire was temporarily extinguished, but, even though the operator was a tall man, and he applied the extinguisher for more than 2 minutes, the flames on top of the transformer continued to blaze and reignited the parts temporarily extinguished by the blanket. After some minutes of this, the fixed-piping system was again actuated, and the fire was quenched in less than 5 seconds. Side and ground fires were extinguished with the wheeled unit.

This demonstration showed clearly that the most efficient protective system for a large transformer is a fixed-piping system to deal with fires on top of the transformer, and a wheeled unit to take care of side and ground fires.

Fig. 1. Oil-fed flames on top of transformer were quickly extinguished by fixed-pipe system at demonstration

Fig. 2. Wheeled chemical extinguisher was effective for side and ground fires but not for fire on top of transformer

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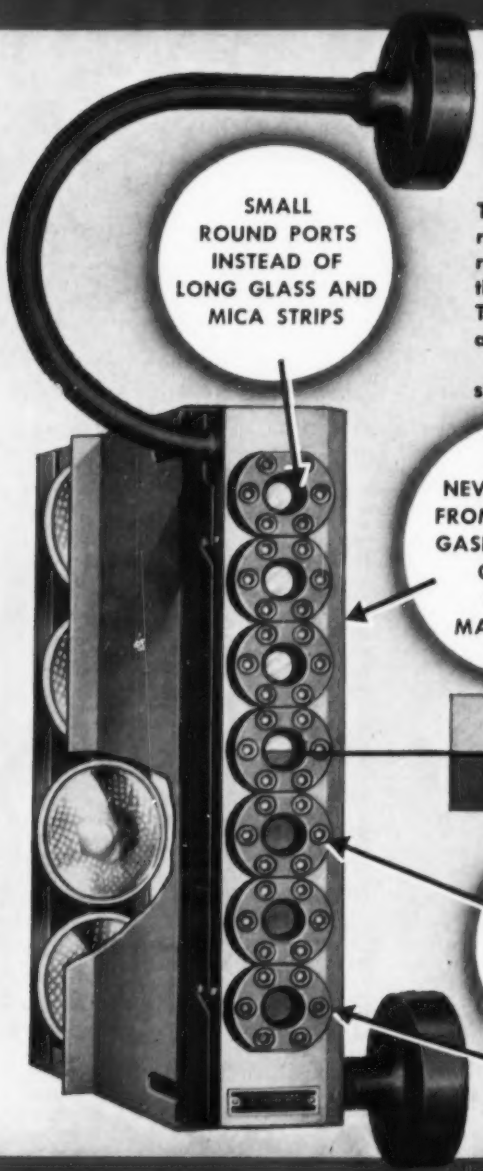
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19th American Power Conference Program

Top men in power engineering field will present latest data on nuclear energy, central station and industrial steam power plant problems, power system operation, water technology, extra high voltage—March 27—29, Hotel Sherman, Chicago

AS NOTED in the February issue, the 19th Annual Meeting of the American Power Conference March 27 at Chicago will highlight many recent power engineering developments. The general topics at luncheons and banquet and the special speakers for the occasion were detailed in the February article. Here are the principal technical topics to be covered.

In the Steam Generator Field, Walter F. Portzline of Foster Wheeler will cover Economic Effects of Steam Preheating Combustion Air on Air Heater and Economizer Design; Samuel A. Arnow of Philadelphia Electric Co will discuss Incorporating Heat from Stack Gases Into Supercritical Heat Cycle at Eddystone Station; E. M. Powell of Combustion Engineering will give Operating Experiences with Twin-Furance Boilers; and D. R. Wilson of the Babcock & Wilcox Co will describe Advances in the Field of Large Steam Generators.

Water Technology will be thoroughly covered in four sessions. Ben Varow of Richfield Oil Co and S. B. Applebaum of Cochrane Corp are to cover An Application of Hot Lime Zeolite to Moderate High-Pressure Boiler Operation. J. E. Hardin and Glenn Hull of Standard Oil Co of Indiana will describe Operation of a Large Hot-Lime-Zeolite System for High-Pressure Boilers; and Louis F. Wirth of National Aluminate will report on a Survey of Operating Plants, Problems and Successful Operation.

On the subject of Hydrazine, N. L. Dickenson and I. N. Felgar of the B&W Research Center will discuss The Hydrazine Reaction in Boiler Feedwater; Robert Hess of Connecticut Light & Power Co (see PoE, September 1955) will give Recent Application Results of Hydrazine-Sodium Sulfite Combination; M. D. Baker of West Penn Power Co will detail Three Years' Experience with Hydrazine.

In a third Water Technology Session, P. B. Place of West Penn Power Co will give the Report of the Joint Research Committee; Paul H. Caskey, Illinois Water Treatment Co, will discuss Counter-flow Regeneration of Deionizers and R. Dvorin, J. H. Duff, J. Levendusky and M. Lane, all of Graver Water Conditioning Co, will present Anion Exchange Sub-Fill as a Factor in Rinse Requirements of Demineralizers.

In a fourth session, Aluminous Condenser Tubes — Report on a Plant Installation will be given by W. A. Pollack of Wisconsin Electric Power Co with prepared discussions by R. A. Wilson of Allis-Chalmers and Ellis Verink of Aluminum Co of America. Method of Measurement and Recording of Small Concentrations of Oxygen Dissolved in Water will be described by M. W. Greene and R. W. Negus of Arnold O. Beckman, Inc.

Industrial Power Plants will be discussed in four papers. New Combined Steam-Gas-Turbine Industrial Power Plant will be described by W. B. Wilson of G-E; Distribution of Steam and Electric Power Costs in an Industrial Plant will be explained by H. P. Kallen of *Power;* Incremental Efficiency Testing of Industrial Turbine Generators to Determine Steam Rates and Valve Points will be reported by Gerald L. Decker of Dow Chemical Co, while Aaron D. Brooks, also of Dow, will report on Economic Dispatching of Industrial Turbine Generators by Valve Points Using a Digital Computer.

Economics of Higher Pressures and Temperatures for Steam Turbines in Industry will be given by M. M. Patterson and W. B. Wilson of G-E; The Eddystone Super-Pressure Turbine will be described by C. C. Frank of Westinghouse and Advances in the Field of Large Steam Turbines will be covered by C. D. Wilson of Allis-Chalmers. On Gas Turbines, George H. Krapf of U. S. Steel Corp will give an Operator's Evaluation of the Versatile Gas Turbine; T. J. Putz of Westinghouse will describe The Mene Grande Gas Turbine Plant; A. R. LeBailly and L. Skog, of Sargent & Lundy, will present Design and Characteristics of a Combined Gas and Steam Cycle for a 40,000-kw unit; E. L. Richardson of G-E and E. L. Daman of Foster Wheeler (see PoE June 1956) will discuss Economics of Small Supercharged Plants.

On Condensers, R. A. Wilson of Allis-Chalmers will review Developments Covering Welding of Non-Ferrous Tubes in Steam Surface Condensers, while George A. Worn of the Lummus Co will discuss Fundamental Need for Welding Non-Ferrous Tubes Into Feedwater Heaters.

Progress Report on High-Speed Boiler Feed Pumps will be given by I. J. Karassik and T. W. Edwards of Worthington; and Boiler Feed Pumps for Supercritical Power Plants will be described by Hans Hornshuch of Ingersoll-Rand.

Electrical Subjects in the field will be thoroughly covered in many papers. In two Electrical Industrial sessions, we will hear first The Viewpoint of the Utility Company, by Charles E. Quick of the Detroit Edison Co; and The Viewpoint of the Manufacturing Company by Frank X. Doran of Ford Motor Co.

Lyle W. Morton of G-E will discuss Semi-Conductor Power Rectifiers, and W. B. Weathers of Westinghouse will discuss Static Control — A New and Reliable Electrical System for Industry.

Extra-High-Voltage Systems here and abroad will receive attention. Francois M. Cahen of Electricite de France will describe Application of Extra High Voltage in France. F. J. Lane of the Central Electricity Authority will describe the 275-kv System of the CEA in the United Kingdom. Gunnar Jancke of the Swedish State Power Board will tell about the Swedish 400-kv System. Eugene C. Starr of the Bonneville Power Administration will discuss Considerations in the Transition to Extra-High-Voltage Transmission. F. A. Lane of American Gas & Electric Service Corp will describe the 345-kv Systems of AG&E and OVEC.

Improving Radio and Television Influence of Power Lines will be covered by F. L. Greene of Ohio Power Co and Maintenance Problems of Electronic Equipment in New Generating Stations by R. V. Sperlik of Commonwealth Edison Co.

Integration of Hydroelectric and Steam Power on the Pacific Gas & Electric System will be described by Walter Dreyer of PG&E and Economics of Power Generation for the TVA System will be given by Robert A. Monroe of TVA.

The Detroit Edison Co's Standards for Residential Underground Distribution will be presented by E. C. De Baene and L. J. Van Tuyl of Detroit Edison. Distribution Transformer Loading by the Load Factor Computer Method will be explained by Perry Brittain of Dallas Power & Light Co. Distribution Transformer Loading from Customers' Kwh Consumption will be given by Hugh Lawyer of Oklahoma Gas & Electric Co.

Turbines, Condensers and Feedwater Heaters and the Laboratories that Make Them Possible will be told by M. L. Mochel of Westinghouse. Recent Progress in H-P, ***continued on page 100***

Building "A Case for the future"

Cleveland's Case Institute approves GILSULATE® for underground hot pipe insulation

Major Expansion Program at Case Institute, leading Midwest technical center, includes plans for several new buildings. GILSULATE has been used and approved by Case on these projects.

300-Foot Replacement Line for existing buildings. Case is replacing all lines with GILSULATE. Thus far, 1900 feet of GILSULATE-protected steam and return lines are on the Case campus.

Pouring GILSULATE is a simple job. Plywood forms conserve material. This is a close-up of the pipe run shown at the left. No special equipment is required during handling.

Shovel Pointing works GILSULATE between and under the pipes, filling all the voids. GILSULATE is ideal for use under roads and pavements, has a high load bearing capacity.

Tamping is the next step. It firms the GILSULATE bed prior to curing. Backfilling, seen in the overall view, is the final step. Few men are needed on a GILSULATE job.

Two-year-old Line on Case campus, dug up for experimental purposes, shows pipes to be in perfect condition, with intact GILSULATE protective structure.

Facts about Gilsulate

1. EASY TO USE—just pour and tamp...pipe heat does the rest.
2. FORMS 3 ZONES of protection against heat loss and all hazards commonly encountered by hot buried pipes.
3. NEEDS NO HOUSING OR MECHANICAL SHEATHS: no mixing, special handling or equipment.
4. ONLY NEEDS NORMAL PIPE SPACING: for multiple pipe or cramped conditions.
5. THREE TYPES AVAILABLE:
   Type A for 220°-300°F temp. range
   Type B for 300°-385°F temp. range
   Type C for 385°-520°F temp. range

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The Triple Zone Insulation System for Lifetime Protection of Underground Hot Pipes

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AMERICAN GILSONITE COMPANY

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3537 Lee Road, Cleveland 20, Ohio

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Power Engineering handbook

Tips on Diesel Engine Maintenance*

A DIESEL ENGINE is a valuable piece of machinery in any plant and while most are designed for extremely rugged service, careful attention should be given to proper lubrication procedures. If excessive bearing wear or failure occurs, the operator should immediately check the following possible causes:

1. Corrosive oil
2. Contaminated oil
3. Incorrect oil viscosity
4. Water in oil
5. Insufficient oil

For High Oil Temperatures, Check:

1. Incorrect oil viscosity
2. Insufficient oil
3. Clogged oil cooler
4. Clogged oil lines
5. Dirt or sludge in crankcase

If Crankcase Deposits are found, Check:

1. High oil temperature
2. Low oil temperature
3. Water leak in crankcase

In addition to these hazards, improper lubrication may result in sticky rings, combustion chamber deposits, and a lack of power and efficiency.

Engine Parts

The engine parts of a diesel engine are carefully designed and engineered components, which together produce the desired power and efficiency of the diesel unit.

Each working part must be considered vital to the overall engine and should therefore receive careful attention.

Following is a handy check list for maintaining precision engine parts:

1. Never handle pistons or cylinders to allow distortion
2. Periodically check piston and liners for wear
3. Check for correct piston clearance
4. Periodically check piston cooling system
5. Check for worn or weak rings
6. Allow sufficient ring side clearance and end clearance
7. Be sure oil ring control is effective
8. Keep crankcase breather-vent clean
9. Maintain proper bearing clearance
10. Never allow bearings to wear to the point of misalignment
11. Keep intake and exhaust valves maintained and tight
12. Guard against overheating of bearings

Gas and Fuel Oil Systems

Extra time and planning will not only reduce fuel costs for the operator of a diesel engine, but will ensure full combustion efficiency and power.

If your daily log indicates that improper combustion or lack of power is occurring, an immediate check should be made for the following possible causes:

1. Incorrect injection timing
2. Incorrect injection pressure
3. Plugged fuel oil system
4. Fuel leaks
5. Sticking fuel nozzles
6. Sticking, worn, or leaking inlet and exhaust valves
7. Improper or low grade fuel
8. Water in fuel

*From Engine Department of Worthington Corp

fold along this line—outside edges toward you

Air System

Care of a diesel engine's air system is as vital to efficient performance as any other maintenance and operation procedure.

An insufficient amount of air may result in poor combustion, fuel waste, and an overall lack of power and operating efficiency.

Improper filtration is another danger area in the air system and may often result in excessive wear of the ring and cylinders. Deposits in the combustion chamber may also be caused by poor filtration.

Settings and Balance

Proper timing, settings, and balance should rate top priority for the efficient operation of a diesel engine. If improper combustion or lack of power is noticed, the operator should immediately check for low compression pressure or improper timing. Also check the points tabulated above under the heading Gas and Fuel Oil Systems, to see if you can find the cause.

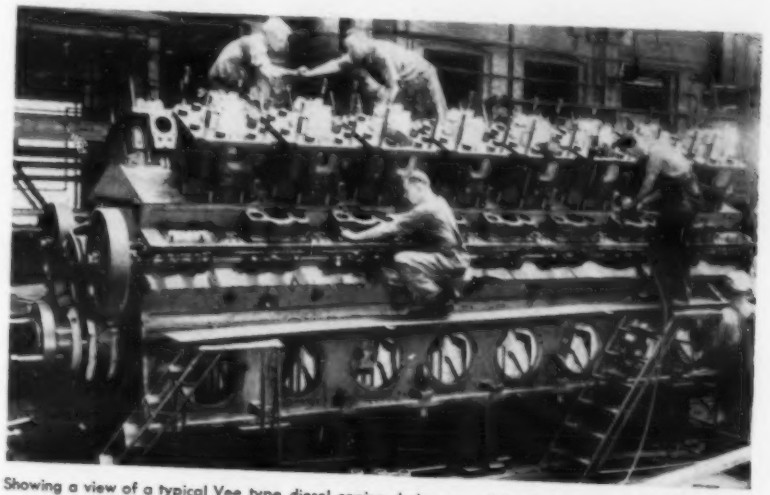
If improper combustion continues, the operator should check for any unbalance of the load between cylinders.

Operation

In the case of increased demands during emergencies, the properly designed stationary diesel engine can be overloaded to 10 per cent of its full load rating for as long as two hours in any 24 hour period.

Regardless of increased emergency demands and so on, the valuable diesel engine should never be continuously overloaded. A continuous overload operation may not only stick rings and deposits in the combustion chamber, but may result in wear, damage, and greatly increased maintenance costs.

To obtain the best combustion from a diesel engine it should be operated between 75 per cent to 100 per cent load. Extremely low operation can also be harmful as it may result in improper combustion which causes deposits in the combustion chamber and crankcase.



Showing a view of a typical Vee type diesel engine during one of the final stages of its construction

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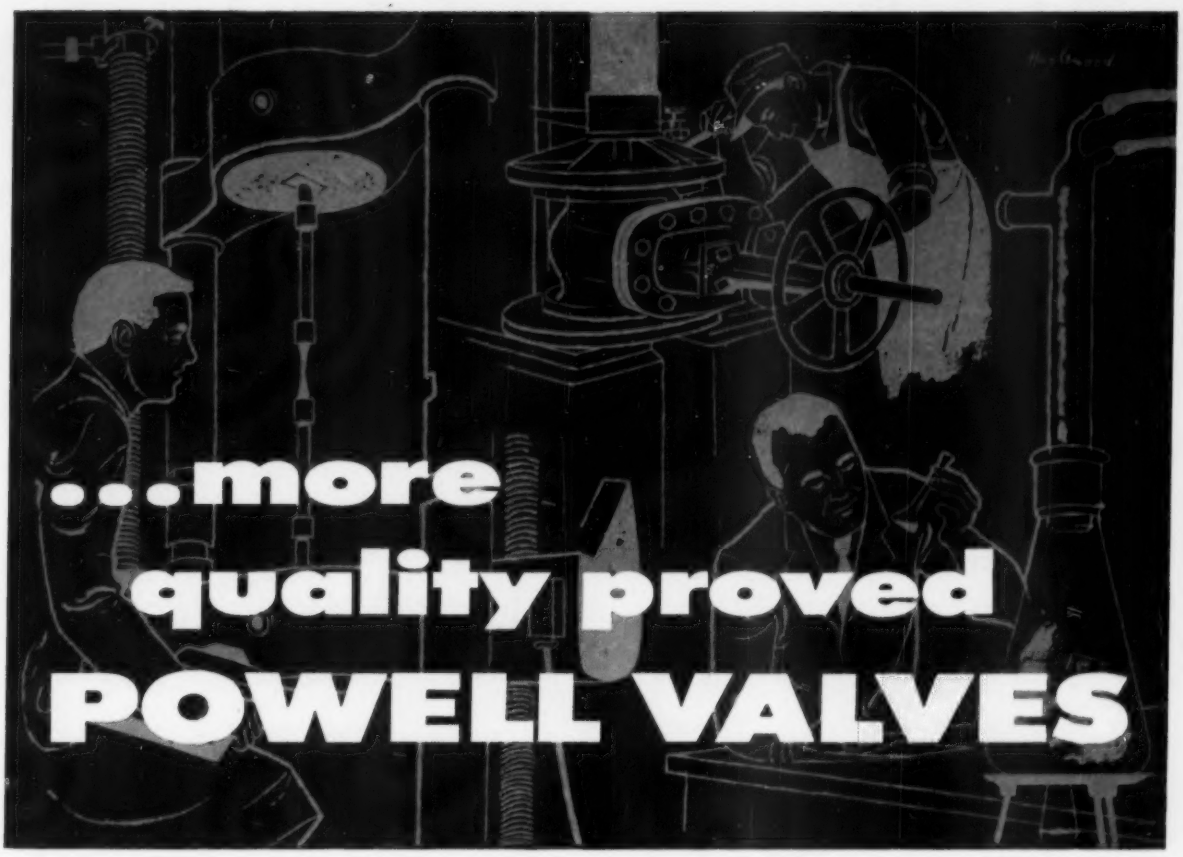


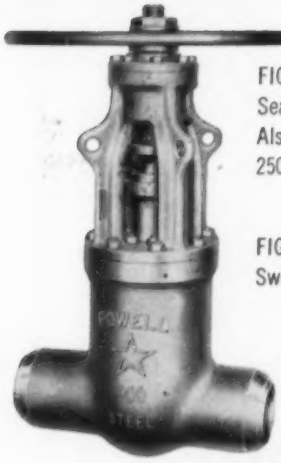
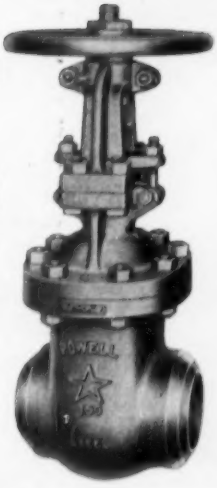


FIG. 19003 W.E.—Steel Pressure Seal Gate Valve for 900 Pounds. Also available for 600, 1500 and 2500 Pounds.

FIG. 3061 W.E.—300-Pound Steel Swing Check Valve.

FIG. 1503 W.E.—150-Pound Steel O.S. & Y. Gate Valve.

FIG. 11365 W.E.—Steel Pressure Seal Horizontal Lift Valve for 1500 Pounds. 900-Pound Valves also available.



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Two Taper Turning Attachments

By F. E. RILEY

First Method

IN TAPER TURNING between centers on the lathe, the longitudinal power feed for the tool carriage can be used only when the lathe is fitted with a taper turning slide, or by setting over the tailstock. Setting over the tailstock is a slow and laborious process disliked by all lathe users since re-setting for parallel turning cannot be accomplished quickly, except by adopting a lot of cut-and-try work.

A simple method of setting over the tailstock center without disturbing the tailstock body setting is illustrated in Fig. 1. A special ball-end center is made with a short parallel shank which will fit without slack in the tool bar hole of an ordinary adjustable boring head; such boring heads are used on milling and jig boring machines and can often be borrowed for use on the lathe.

The boring head is mounted in the taper hole of the lathe tailstock barrel with the longitudinal path of the tool slide arranged to run parallel with the lathe bed top, or the cross slide path. The amount of off-set for the center is adjustable within fine limits by using the micrometer adjustment provided for the tool slide of the boring head.

When it is desired to revert to parallel turning, the boring head and its off-set center are removed from the tailstock barrel and a suitable hardened center is substituted. The change from taper to parallel turning can be done quickly and is very necessary where batches of similar tapered components with parallel portions are being machined in an engine lathe.

The ball-end center shown is a desirable feature when taper turning with either an off-set tailstock or with the boring head attachment. The driving center at the other end of the work should also be of spherical form. The latest idea is to make such centers from cemented carbide so that they resist wear. It can be seen that contact between the work center hole and the spherical center is of simple line contact only and scoring can result from centers which are subjected to excessive end pressure; it is found that cemented carbide resists this scoring tendency.

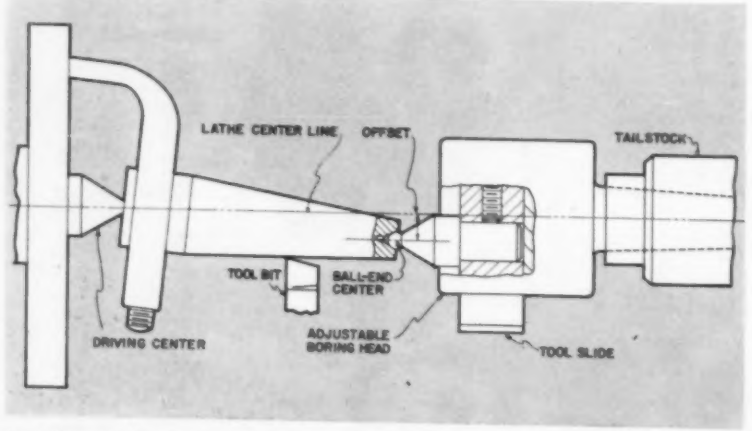

Fig. 1. Taper turning attachment made by utilizing a milling machine or jig borer boring head. Only part necessary to make is ball-end center with straight shank to fit in tool holder of boring head

fold along this line—outside edges toward you

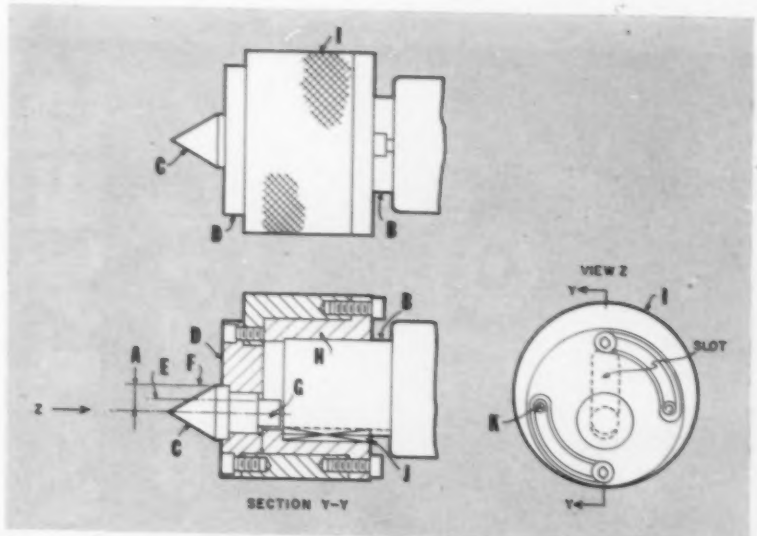

Fig. 2. Attachment for taper turning can be made if boring head is not available. Attachment shown has rigid support by mounting on exterior of the tailstock barrel; most machining is turned on lathe

Second Method

When a boring head cannot be obtained for off-setting the center, the attachment illustrated in Fig. 2 can be made up. It has the advantage that it can be made almost completely by turning. In this tool, the center is off-set by eccentric means and in the example shown, the maximum off-set (A) is $\frac{1}{2}$-in. Another advantage of the device is the low overhang of the center from the front of the tailstock barrel (B) and the rigid support of the center obtained from fitting the attachment to the tailstock barrel exterior, instead of mounting it on a relatively slender taper shank.

A hardened center point (C) is fixed rigidly into the flanged front disk (D) by means of a force fit for the parallel shank; this ensures rigidity and resists any tendency for the center to turn in its location. The axis (E) of the front disk is midway between the maximum off-set position of the center point and the lathe center line (F). Turning the disk (D) through 180 degrees on its axis (E) will bring the center point into alignment with the lathe center line; intermediate positions between these two extremes will give various amounts of off-set.

Rotation of the front plate to obtain various amounts of off-set would result in displacing the center point to positions above or below the lathe axis. It is essential in taper turning that the off-set be only in a horizontal direction. This requirement is obtained from the cylindrical tail portion (G) which is integral with the center point. The tail engages with an elongated slot machined in the front face of the fixed mounting sleeve (H). The slot is visible in the view Z.

This slot precludes any possibility of the front plate being rotated, but the same effect as rotating it can be obtained by revolving the knurled outer sleeve (I), which is bored to take the register of the front plate and is, in turn, supported by the fixed mounting sleeve (H). This sleeve is a push fit on the exterior

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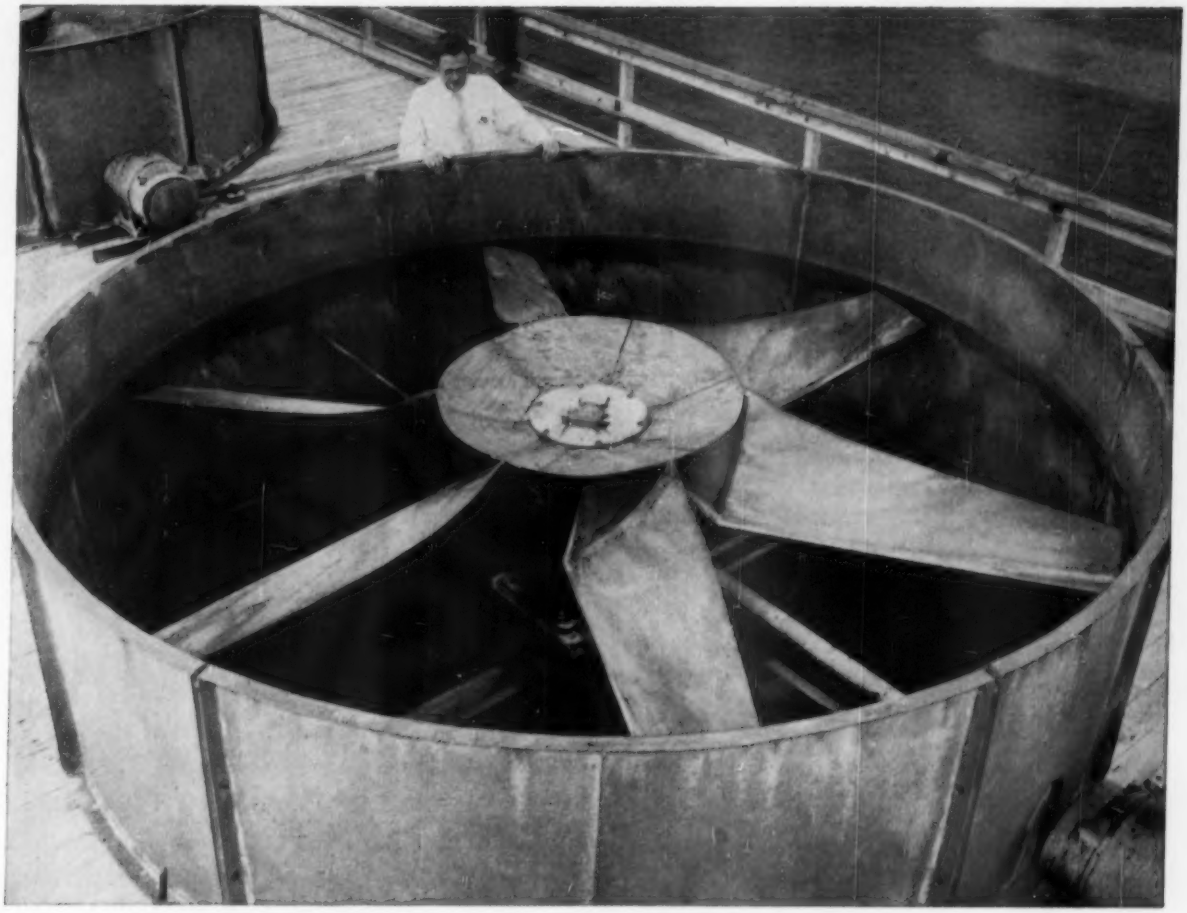

Inspecting Monel blades of 14-foot fan. *Sixteen such fans cool recirculated water for the 32,000 sq. ft. condenser in a 48,000 KW unit of Clark Station (Houston) at a rate of 37,500 G.P.M. After 850-million round trips through alkaline fog these . . .*

tireless Monel fan blades show no erosion and no corrosion

Cooling water for a unit of Houston Lighting & Power Co.'s Clarke Station is drawn from wells . . . recirculated through a condenser.

This water, must, itself be air cooled in a cooling tower. Sixteen, 14-foot diameter Class 7000 Moore fans suck the air through. With it ride millions of droplets of hot alkaline water.

Impact and corrosion from these tiny droplets attack the fan blades. What's more, the blades must absorb enormous numbers of slight flexures . . . and physical shocks caused by turbulence. Not many materials could take it.

But Monel* nickel-copper alloy does.

Look at the Monel alloy blades on the fan shown above! They've already lasted eight years. Made more than 850-million "round" trips without noticeable defect. So have the Monel blades on the other fifteen fans. And they seem to have years of service left.

The Moore Co., Marceline, Mo., says, "In cooling tower fan blades, Monel performs well consistently. And we find it easy to shape and weld."

Maybe you should be using Monel for fan blades and other parts calling for good mechanical properties combined with high corrosion resistance. To look into it, simply contact Inco's Technical Service...an advisory group.

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of the tailstock barrel and is retained in the correct radial position by means of the key (J). The key engages with the longitudinal keyway machined in the tailstock barrel exterior.

The front plate and the external sleeve are each secured in their set positions by means of two set screws. The front plate screw heads are sunk into curved slots machined around the front plate, as shown in view Z. The slots permit only 90 degrees of front plate rotation, but this amount can be doubled by shifting the set screws to the second pair of tapped holes (K). A similar arrangement is used for the fixed mounting sleeve, except that the two set-screws are not sunk into grooves; only curved slots are provided (not shown in figure).

To off-set the center point, all four set-screws are released and the outer sleeve is turned by hand so that the center point travels horizontally. The amount of off-set can be gaged by means of a rule placed between the head-stock and tailstock center points, or by one of the many other methods available. Once the correct off-set has been obtained, the setting can be locked in place by tightening each of the four set-screws.

When it is desired to change from taper to parallel turning, the attachment is slipped off the tailstock barrel and the normal center point fitted into the tapered hole in the barrel.

Make These Carry-All Toggle Tongs

By C. H. WILLEY

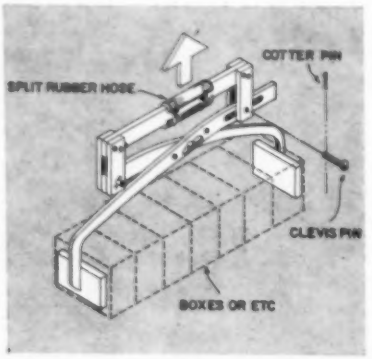
FOR THOSE jobs in which it is necessary to handle quantities of small boxes or similarly-shaped objects, this toggle-type carrier can save a lot of work and fatigue. Like the familiar bricklayer's tongs, the tool is simply placed over the articles to be lifted, then picked up by the handle to clamp the tongs on the load.

Fabrication of the tongs is evident from the illustration. Dimensions should be made to suit the requirements of the job for which they are intended. The handle arm is made from bar or strip stock; the scissor arms can be laid out on a cardboard pattern or drawing and given to an outside shop for flame cutting from plate. Such a shop can also weld the lifting pads to the arms if necessary.

Four bracket plates at the ends of the lifting arm can be secured with bolts and nuts, rivets, or by welding.

If the tongs are made to be adjustable, as are those in the drawing, allow for additional slot length at the loose handle pivot. Make handle grips from split rubber hose and wire into place.

Larger sized tongs, designed for lifting with crane hooks or hoists, can be made by simply scaling up the tool shown here and adding an eye welded to the handle arm.



Toggle tongs for handling quantities of boxes, bricks, etc., save much labor and cost little

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Driving Centered Work in Chuck

By JOHN J. O'BRIEN

IN GENERAL lathe work, the operator does a lot of work in changing over from chuck work to turning between centers. If the chuck is mounted on the lathe spindle and a centered shaft is to be turned, the lathe operator must remove the chuck, mount the center in the head-stock spindle and check it for true running, then mount the face plate for driving the lathe dog clamped to the work.

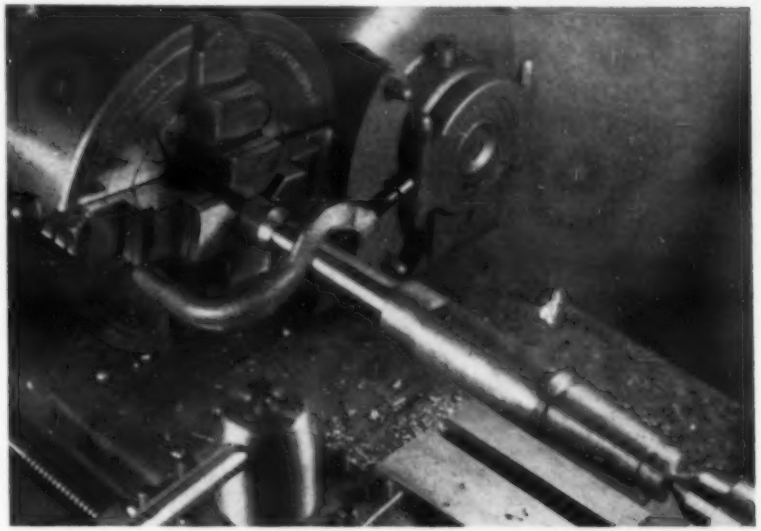
Reverse series of operations takes place when it is desired to revert to chuck work again. On small lathes, the work of removing and remounting the chuck is not a great hardship, but on lathes swinging a diameter of 20 in. the chuck can represent a very heavy weight and will require more than one pair of hands to remove.

Simplest way to avoid a lot of hard work and wasted time is to keep the chuck mounted permanently on the lathe spindle. This can be done during turning between centers by the method illustrated.

A short piece of scrap high tensile steel bar is gripped in the chuck jaws and a standard center point of 60° included angle is turned on the end. The point can be turned easily by swivelling the compound slide rest to the appropriate 30° angle.

Advantage of the turned center point is that it always runs dead true, no matter how old and worn the lathe may be. The work is driven on the centers in the usual manner by means of a lathe dog which engages with one of the chuck jaws.

The turned center can be re-used many times by gripping it in the lathe chuck and truing it up with the compound slide. The labor involved in skimming up a true center point is small in comparison to that required for lifting heavy chucks off and on the lathe spindle.



To save removing chuck for turning centered work, make center in place by turning stock in chuck jaws

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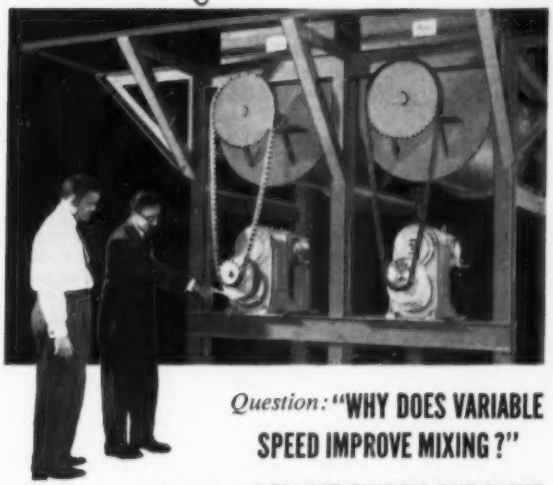
VARIABLE SPEEDS
FOR VARYING NEEDS---MIXING



Question: "WHY DOES VARIABLE SPEED IMPROVE MIXING?"

Answer: "BECAUSE THERE'S ONE RIGHT SPEED FOR EVERY MIXING CONDITION—"

for example:

VISCOUS MATERIALS-Where dry ingredients are mixed or reacted with vehicles or binders, the materials may go through a plastic state in their reaction; therefore variable speed increases or decreases rpm speed to accommodate the process requirements.

TEMPERATURE VARIATIONS-When liquids or semi-solids undergoing mixing lose heat, the speed of the mixer may require reduction progressively or in steps. A Varidrive will give you the precise speeds needed at different levels of temperature.

BATCH BLENDING-Different consistencies of batch materials may require slow speed to start, but when they become integrated, higher speed may be applied to reduce time. The same mixer can be used for processing materials of widely varying consistencies by powering it with a Varidrive. Thus you save space and extra equipment.

EXPERIMENTAL PROCESSES-You may want to mix new compounds or blends to determine how slow or fast you should make up the batch. Only by variable speed can you get the sensitive rpm needed for experimenting. Varidrive is the answer.

INCREASED VERSATILITY-A mixer can be used for many operations with variable speed, whereas a single-speed will restrict its use. A Varidrive gives a mixer its full potential of performance so that you may be able to avoid purchase of extra mixers.

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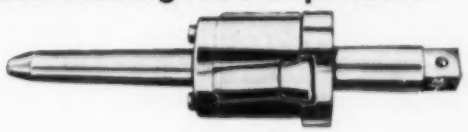
Keep boilers on the line with

WILSON Maintenance Tools

Heavy-duty air driven tube cleaners

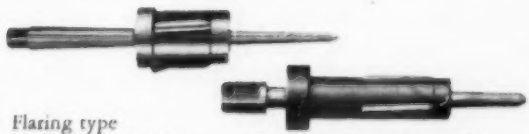
Designed to deliver maximum power at the most efficient cutter head speeds while negotiating sharp bends, the Model ECT Air Cleaners are excellent for cleaning curved boiler tubes from 2½" to 4½" O.D.

Self-feeding tube expanders



Wilson Model 38 tube expanders are self-feeding and parallel expanding. They are of the single flare roll type. Available for tubes 1" O.D. to 4½" O.D. with various roll lengths for tube seats ¾" and up.

Model E Expanders



Flaring type expander 1" O.D. to 4½" O.D. tubes, ½" to 2" tube seats

Long reach type expander 1" O.D. to 4½" O.D. tubes, 2½" to 5" tube seats

Right angle bevel gear drive

This Wilson bevel gear drive is expressly manufactured to meet continuous and heavy duty service conditions. The one piece all steel body is extremely rigid and not subject to distortion. The maintenance of perfect gear alignment is assured with consequent long service life.

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What They Tell Us

continued from page 6

pressure boilers generally operate with lower carbon dioxide content in the steam which makes the filming amines less desirable than other treatments.

Furthermore, the sulfate salt of the waxy amines is insoluble; hence, any amine returned to the boiler by way of the condensate is precipitated in the boiler if the sulfate ion is present. This sulfate will stick to the tubes in areas of high heat transfer and eventually will cause trouble. Such troubles are more prevalent in high pressure boilers.

The statement that the amine film usually has a low heat transfer coefficient can hardly be controverted. Perhaps the film may be so thin that the loss of heat transfer by reason of the film may be immeasurable when compared to the improvement in heat transfer as a result of removing deposits. Even so, an organic film of this sort does have a low heat transfer coefficient compared to water.

However, in reply to Scharp's explanation, Denman still stuck to his guns and offered the following explanation:

Wording of the statement that "filming amines are primarily applicable to pressures below about 200 psig" is the basic cause of the present discussion. Several persons have interpreted this statement to mean that filming amines should not be used above 200 psig. Readers should be given sufficient detail to permit understanding the extent filming amines are applicable.

In usage of chemicals for feedwater conditioning in steam generation boilers operating at 200 psig or less may consume the bulk of filming amines follows the same pattern. Further, in general as boiler pressures increase above 200 psig more attention is given operating conditions, such as external chemical and mechanical handling of water, oxygen removal from feed water, prevention of air leakage into condensate lines, and so on.

Even so, many higher pressure boiler plants desire to reduce corrosion in the steam-water cycle. Our experience has shown that filming amines give significant reduction in corrosion rates in boiler plants operating up to 600 psig and 750 F. superheat.

It is the temperature of the portion of the boiler tube in question and not the boiler pressure that is the controlling factor. Actually the controlling factor is the rate of heat transfer. Further, we all recognize that at times boilers develop hot spots due to overloading or incorrect design. Because of this fact it is essential that water conditioning and

chemical feed to steam systems be done in an intelligent manner. Likewise, intelligent application of filming amines will give satisfactory results.

Mr. Scharp's comment regarding cleaning procedure used for removing filming amine deposits needs further investigation. Since amines are alkaline chemicals, removal usually involves acidic cleaning agents. Filming amines have the property of displacing and removing many types of old deposits including oils, and it is possible that the deposit to which Mr. Scharp referred was not amine in nature.

Filming amines are very weak bases and any sulfate salt of filming amines must undergo hydrolysis in water. In the presence of the hydroxyl alkalinity of boiler water this hydrolysis is complete and the free filming amine steam distills with the steam. For this reason it is difficult to visualize formation of amine sulfate deposits in presence of alkaline boiler water.

The last sentence "Even so, an organic film of this sort does have a low heat transfer coefficient compared to water" is correct only if comparison is made with an equal thickness of water. As stated, it is misleading to a reader.

From basic equation of flow of heat for such systems in which h_i is the film coefficient of heat transfer on the condensing steam side filming amines affect h_i by promoting dropwise condensation. In normal film condensation, h_i varies between 1000 and 2000 while for dropwise condensation, as produced by filming amines, h_i varies between 10,000 to 20,000 and at times has been reported at 70,000.

Overall improvement in heat transfer rate obtained from use of filming amines results from a combination of two factors; namely, by removal of the so-called fouling factor, and by increasing the film coefficient at the condensing steam-heat exchanger tube interface. The fouling factor includes the effect of the film of corrosion products, scale, etc. and represents the resistance to flow of heat by this film. With film condensation at the condensing steam-heat exchanger tube interface, the condensed continuous layer or film of water offers resistance to heat flow because of its limiting thermal conductivity. When the mode of condensation is changed from film to dropwise condensation a large area of tubing is actually naked except for an extremely thin film of amine.

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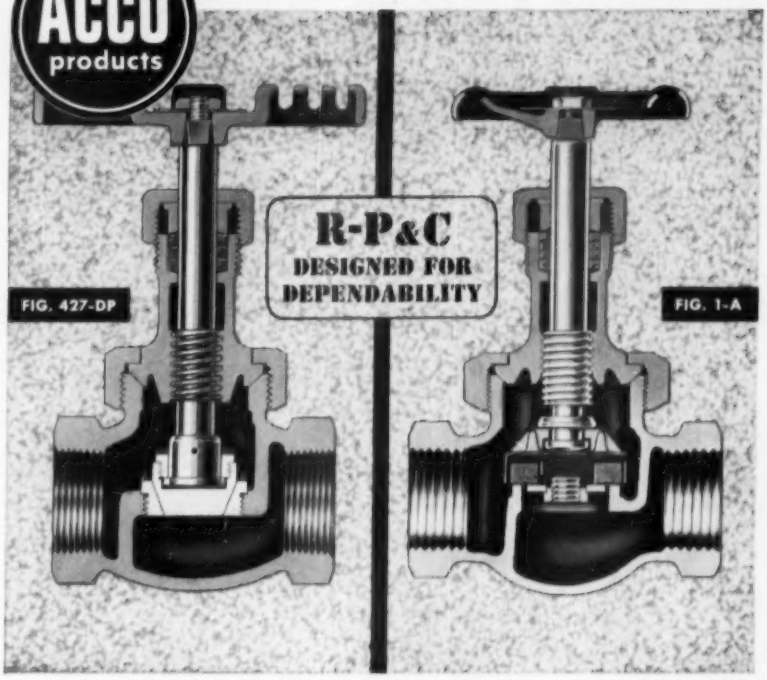

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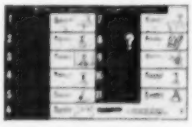

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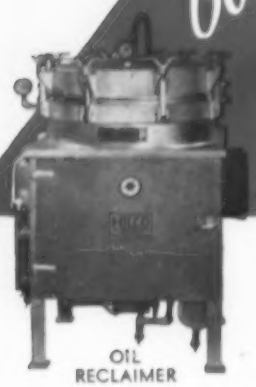

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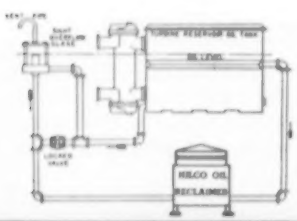

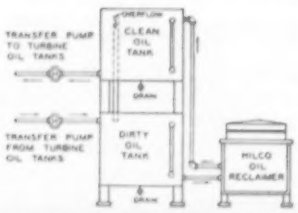

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Power Conference

continued from page 90

H-T Power Generation in Great Britain is to be reviewed by J. W. H. Dore of the Central Electricity Authority. Future of the Steam Cycle will be forecast by C. W. Elston and J. E. Cowns of G-E.

Frequency and Load Control Problems in a Large Power System will be presented by C. L. Karr of TVA; Operating Experiences with Area Control by Donald C. Peterson of Northern States Power Co; Operating Experience with Dispatch Computer in Automatic Power System Control by R. H. Travers of Ohio Edison and S. B. Yochelson of Goodyear Aircraft; and The Common Sense of Increment Loading by Lester B. Le Vesconte of Sargent & Lundy.

There will be a session on Research in the Power Industry, including a panel discussion, papers to be announced, also a session on fuels.

Use of Digital Computers for solving mechanical problems will be illustrated by a paper on their Use for Piping Flexibility Calculations by T. Kolflat and H. E. Knapp of Sargent & Lundy and another on Generalized Heat Balance Computation on the IBM 650 EDPM by Robert K. Large of Detroit Edison and J. E. Gerngross of G-E.

Symposium on Computers and Network Analyzers will include several papers on their applications in power systems engineering.

Nuclear Energy will be covered in a session of four papers: Inter-American Progress Toward Economic Nuclear Power by Walter F. Friend and Leonard F. C. Reiche of Ebasco Services; Significant Developments in Large Boiling Water Reactor Plants, by Raymond C. Freeman of G-E; Plant Design and Operating Problems of the Pennsylvania Advanced Reactor by W. E. Johnson of Pennsylvania Advanced Reactor Project; and a New Approach to Design of Containment Shells for Atomic Power Plants by Alf Kolflat and W. A. Chittenden of Sargent & Lundy.

Single Phasing

continued from page 76

If a three-phase motor is single-phased while it is running, and if the motor continues to run, motor speed does not change significantly, and cooling effect due to windage remains about the same. The motor windings which carry an increased current are heating in the same manner as if the motor were carrying a balanced three-phase overload. Since at least one overload relay will remain in the circuit upon single-phasing, relays which are adequate for protecting a three-phase motor against overloading are also adequate for giving running protection upon single-phasing.

Since U. S.-built motors with delta-connected stator winding are laid out with reduced maximum current-density in the conductors, they are

afforded the same degree of protection against single-phasing by thermal overload relays as equivalent motors with wye-connected stator. This does not necessarily hold true when U. S.-built controllers are used with foreign-built motors. On many such motors, the same current densities are used for delta- and for wye-connected stators, and motor builders expect control manufacturers to provide specific protection against single-phasing.

Locked-rotor current upon single-phasing being reduced below the symmetrical three-phase value, permissible stall time is increased correspondingly. Whether or not the thermal relay characteristics of Fig. 4 will provide proper single-phased stall protection is not directly apparent from the shape of the curve. However, numerous tests conducted on combinations of motors and starters have proven that present-day squirrel-cage motors are adequately protected against single-phased stalling by properly selected overload relays which provide stall protection during regular three-phase operation.

From the foregoing considerations it can be concluded that single-phasing of the branch circuit feeding three-phase motors need not be feared as a cause of motor burn-out over and above those causes safeguarded against by up-to-date motor controllers. If a motor is protected by properly designed and selected thermal overload relays, which afford adequate protection against running overloads as well as stalling under three-phase operating conditions, the same relays can be expected to protect the motor properly when the stator is single-phased.

Two thermal overload relays, one in each of two phases, as used on standard three-phase starters, suffice to protect motors upon single-phasing, except when motors are connected to wye-delta or delta-wye connected step-down transformer. In this case the use of a third overload relay may be necessary.

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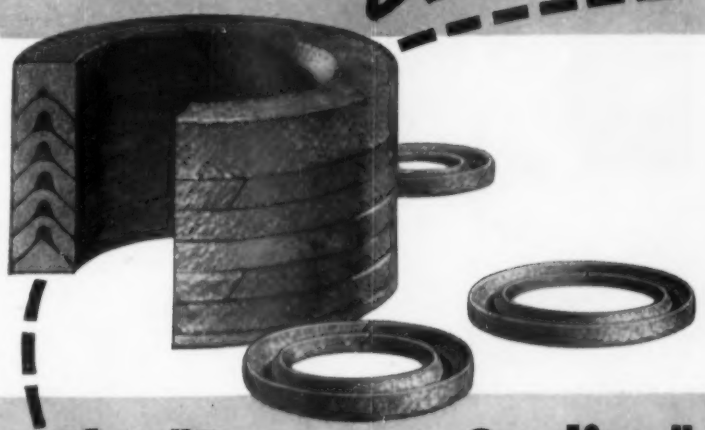

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How Do You Operate Your BF Pumps?

continued from page 68

danger of losing feedwater if a single pump is on the line and quits, it should be remembered all idle pumps are kept warmed up and ready to start — even automatically, if desired. Achieving full speed from a dead stop is a matter of seconds at most.

It should be apparent by now that the author very firmly believes that no pump should be left on the line when the required flow can be handled without it. It remains to give a few words of caution on this method of operation and to cite the one reommended exception.

Single Recommended Exception

From Fig. 3, it is obvious that a single pump will intersect the system-head curve at a capacity appreciably in excess of one-half the maximum capacity. If the pump driver and the suction conditions have been selected with this possibility in mind, all is well. If, however, operation to the right of the design point (as, for instance, beyond 1100 gpm, Fig. 2) will cause overload of the driver or introduce NPSH (net positive suction head) problems, means must be incorporated to avoid this possibility. In the first place, whenever a scheduled load increase is foreseen, the second pump should be started slightly ahead of the actual rise in feedwater demand. In addition, to protect the installation against an unforeseen and sudden load increase, a pressure switch can be placed in the discharge header. This pressure switch will automatically start a second pump whenever the header pressure falls below a predetermined minimum, selected to avoid driver overload or suction troubles.

Exception Is Initial Operation

The exception has to do with the initial plant operation period. It is during this time that most difficulties arise to plague the boiler feed pumps, the plant operators and the pump manufacturers. Despite all precautions, mill scale and particles of black oxide keep finding their way into the pumps and threaten to cause seizures at the close clearance internal running joints. Power plants with open feedwater cycles run into fluctuating pressure and temperature conditions which lead to NPSH deficiencies and flashing. And while no plant is ever free of these hazards, they generally loom much larger in the first two to eight weeks of the plant's life.

First part of this article has treated of the problems arising from these hazards and of the fact that the danger to a pump is greater when it is shut down and is coasting to a stop. For that reason, it is recommended to avoid shutting down boiler feed pumps more often than it is absolutely necessary; and the rule we have just finished proving, to shut down one of the pumps whenever the load permits, should be suspended in the early stages of plant operation. After everything has shaken itself down to normal, after most foreign matter has been washed out and only the normal share of transient conditions is expected, pumps can be shut down and restarted as the load requires.

We might add that for simplicity we have discussed the case of constant-speed pumps only. While the exact savings to be gained by running a single pump at light loads may be somewhat different in the case of variable-speed pumps driven through a hydraulic coupling or by a steam turbine, the general conclusion remains unaffected by the method of drive.

References

[1] How to Calculate Temperature Rise in Centrifugal Pumps on Closed Discharge. By I. J. Karassik and T. W. Edwards, *Industry and Power*, June 1955. (Worthington reprint RP-737.)

[2] Group of 3 articles by I. J. Karassik, G. H. Bosworth and W. D. Elston, *Power:* Effect of Sudden Load Drop in Open Feed Cycles, October 1955; Designing for Load Drop in Open Feed Systems, November 1955; How Load Changes Affect Closed Feed Cycles, January 1956.

[3] Protect Your Feed Pumps Against Reverse Rotation. By T. W. Edwards and I. J. Karassik, *Industry and Power*, May 1956. (Worthington reprint RP-863.)

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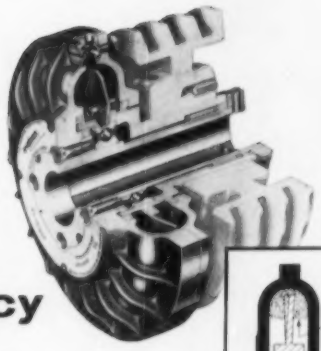

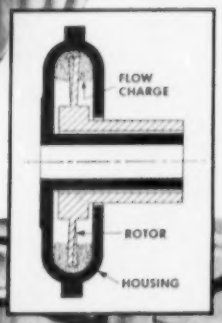

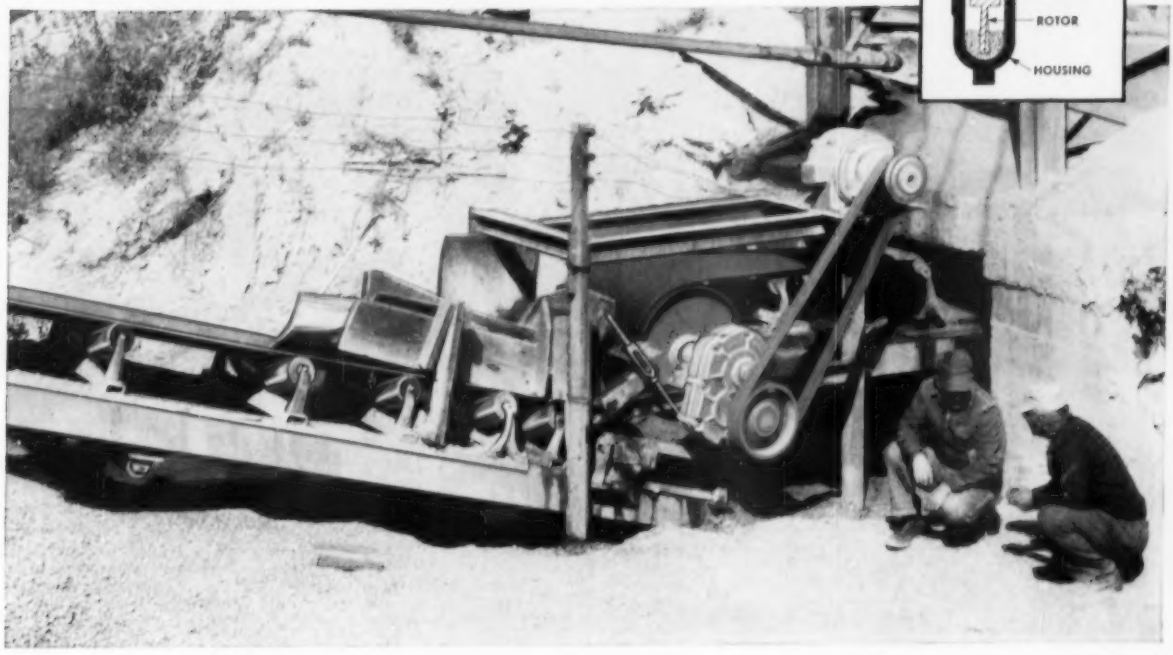

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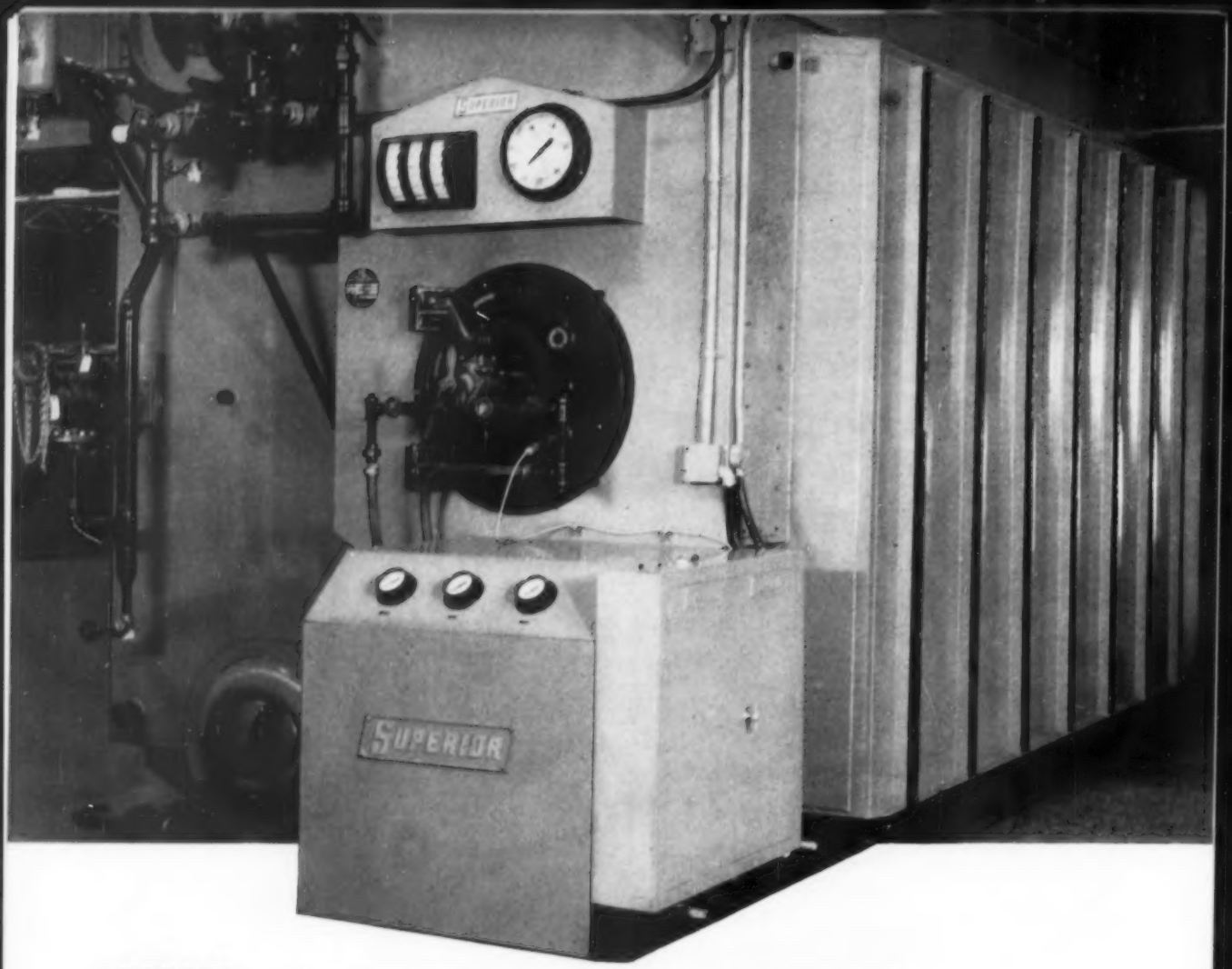

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201 **Packaged Boilers** — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 40,000 lb per hour. Space requirements are shown in a table with specifications. Combustion Engineering, Inc.

202 **Steam Generators** — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

203 **Improved Steam Generator** — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

204 **Boiler Family** — Bulletin B-3300-A describes a wide range of company's heating and power boilers and includes photos and cutaway views showing construction features. A list of bulletins on the various types of boilers is included. Titusville Iron Works Div., Struthers Wells Corp.

205 **Standard Generators** — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of the units and design features are included. Foster Wheeler Corp.

206 **Water Tube Boilers** — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

207 **Packaged Generators** — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement lay-

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outs, construction details, auxiliary equipment, dimensions. Union Iron Works.

208 Shop Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

TUBING AND ACCESSORIES

209 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

210 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

211 Tube Tools — Eight-pp Bulletin 58 describes advantages and application of company's line of tube cleaners, tube expanders and maintenance tools, including drills, brushes, accessory and specialty tools. Photos are included as well as size and selection data. Airetool Mfg. Co.

212 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required tubing that would withstand this rigorous wear. The International Nickel Co., Inc.

213 Tube Expanders — Catalog 88, 119-pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and charts giving sizes. Thomas C. Wilson, Inc.

VALVES, TRAPS, PIPING AND ACCESSORIES

214 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

215 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed

MARCH, 1957

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drawings. Also included is physical data on dimensions. The Wm. Powell Co.

216 General Purpose Valves — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

217 Valve Chart — Form 194, 22 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

218 Diaphragm Motor Valve — Bulletin J-170 describes outstanding features of company's diaphragm motor valve designed for accurate control of pressure, temperature, rate of flow, and liquid level. Cutaway view showing component parts is included, along with data on materials of construction, capacity tables, and flow diagram. The Jordan Corp.

219 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

220 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and test data is presented to show efficiency of company's silent check valves in water hammer control. Some typical installations are illustrated. The Williams Gauge Co., Inc.

221 Valve Charts — Now available to power engineers are three well-organized wall charts on valve types, selection and protection. "How to know valves" covers four main types of valves from the standpoints of their appearance, inside construction, service intended, operation and use. "How to select valves" discusses five major factors involved in the choice of a valve — fluid, temperature, pressure, size and function. "How to protect valves" — written in "do and don't" style covers 11 important points in valve installation, operation and maintenance. R-P & C Valve Div., American Chain & Cable Co., Inc.

222 Pump Valves — Key features of company's line of pump valves are outlined in 6-pp Bulletin V-112. Includes cutaway view showing design features, standard materials table, and a table of standard pump valve sizes. Sims Pump Valve Co., Inc.

223 Choosing the Right Valve — Presenting valve selection as a matter of matching the valves's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

224 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

225 Valve Data — This loose-leaf notebook contains a collection of company's bulletins on its line of valves for control of air, gas, liquids and solids. It features complete operating, design, dimensional and specification data on butterfly, slide, automatic and proportioning valves, and is profusely illustrated with photos, drawings and diagrams, highlighting valve design and construction. W. S. Rockwell Co.

226 Industrial Valves — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

227 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section ex-

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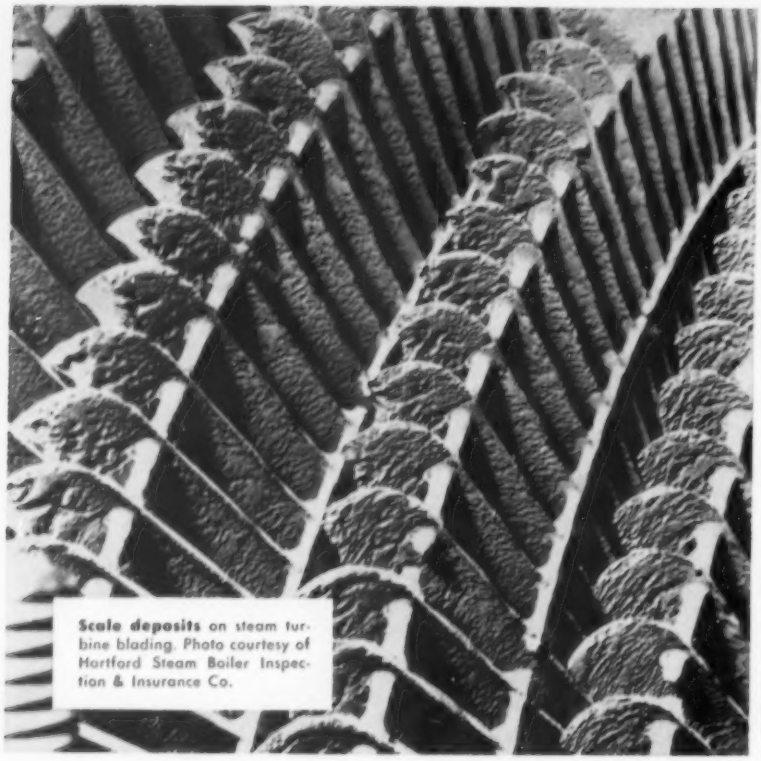

Scale deposits on steam turbine blading. Photo courtesy of Hartford Steam Boiler Inspection & Insurance Co.

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plaining trap installation, as well as trouble-shooting and repair. Armstrong Machine Works.

228 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

229 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

MECHANICAL POWER TRANSMISSION

230 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multicolor tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

231 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

WATER CONDITIONING

232 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

233 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

234 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrite, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations,

methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers. W. A. Taylor Co.

235 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

236 Carbon Dioxide Measurement — Technical Paper 133, 16-pp, discusses determination of CO_2 in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. W. H. & L. D. Betz.

237 Deaeration Literature — The facts about deaeration are thoroughly reviewed in a series of bulletins available from the company. What deaeration is, why it is necessary, and types of deaerators are among the subjects covered in one of the bulletins. Others in the series describe various types of deaeration equipment, including the Jet-Tray deaerator, tray-type deaerators, cold water deaerators, a surface type deaerating hot water heater, boiler feedwater deaerating heater, and atomizing deaerators. Cochrane Corp.

238 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization at flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

ELECTRICAL EQUIPMENT

239 Testing Instruments — Bulletin 19–57, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

240 Industrial Systems — Bulletin GED-3039, 48 pp, gives information on distribution system planning. Features, advantages, application, operation and other data on system-engineered equipment for industrial power distribution, including switchgear, unit substations, switchboards, transformers, busways, wire and cable, conduit products, voltage regulators, capacitors, circuit breakers, safety switches, panelboards, controls, motor controls, motors, turbines, rectifiers, and wiring devices are covered. General Electric Co.

241 High Capacity Fuses — Form HCS, 6 pp, describes fuses of unlimited interrupting capacity on voltages to 600, designed to afford protection for loads of 600 to 5000 amp. Includes test data, charts on opening time, current limiting effect. Bussmann Mfg. Co.

242 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor

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Accuracy . . . High Load Capacity . . . Adaptability . . . Freedom from Trouble . . . Long Life . . . Flexibility . . . these are some of the qualities of ACCO TRU-LAY PUSH-PULL FLEXIBLE CONTROLS that have made it possible to improve the operation of literally hundreds of mechanical products (list on request). Full description of this versatile REMOTE CONTROL is given in our DATA FILE available for your further study.

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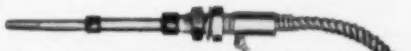

"SOLID as a rod but FLEXIBLE as a wire rope" aptly describes TRU-LAY PUSH-PULL CONTROLS. This *flexibility* provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration—protects delicate instruments . . . it permits ease of handling and shipping even when assemblies are 100 or 150 feet long . . . it avoids the risk of damage always present with solid tubular controls that must be preformed to position . . . and flexibility greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions. . .

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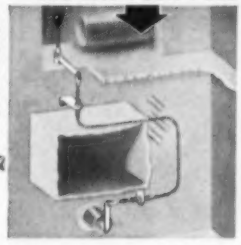

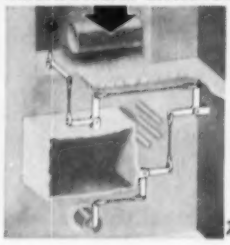

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ADAPTABILITY to all sorts of mechanical situations explains, in large measure, the wide-spread application of TRU-LAY PUSH-PULLS. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters.

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shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

LUBRICANTS

243 Lithium Soap Greases — This product information bulletin details qualities and specifications of company's multi-purpose soap industrial greases. Advantages of multi-purpose grease use — such as prevention of lubricant misapplication, simplified maintenance procedures are discussed, together with performance characteristics. Sinclair Refining Co.

244 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

Do any of these catalogs answer your operating or maintenance needs? Let us know by circling the number of the catalog on the post card provided on pages 105–106. We'll do the rest!

245 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved, in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

INSTRUMENTS, CONTROLS

246 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

247 Instrument Panels — Power and process plants can choose instrument and control panels to meet individual specifications from six standard designs described in 16-pp Product Specification G71-7. Complete specifications are furnished, as well as information on supports and mountings for tubes, wires and equipment, instrument mounting dimensions, and dimensions of standard instrument and control panels. Bailey Meter Co.

248 Oil Leak Detection — Eight-pp illustrated Bulletin 80, on the Paraprobe oil leak detection system for steam-type fuel oil heaters gives a detailed explanation of the operation of the system. Provides installation diagrams, standard specifications, explains determination of condensate flow rate. Davis Engineering Corp.

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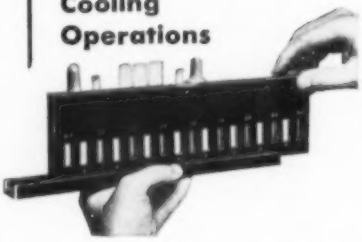

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249 **Easy Reading Gage** — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

250 **Instruments, Controls** — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

251 **Solenoid Pilots** — Several types of solenoid pilots for use with company's regulating valves are described in Form 1010. Lists reasons for economies in on-off control, describes applications, and gives type of pilot, material of construction, maximum pressure and maximum temperature for two- and three-way pilots in steam, gas and liquid service. Schematic diagrams of typical applications are given. Spence Engineering Co., Inc.

252 **Indicating Flow Meter** — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

253 **D-C Amplifier** — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier and describes some applications. Hagan Corp.

254 **Ideas on Push Pull Controls** — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

255 **Sampling System** — A newly developed system for continuous sampling and oxygen measurement of combustion processes is described in Bulletin 703. Points out advantages of system and diagrams component parts. Selection of sampling tube and gas selector units is discussed. Arnold O. Beckman, Inc.

COAL, ASH HANDLING

256 **Tractor Shovel** — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

257 **Coal Crusher** — Company's WC and WS series rolling ring coal crushers

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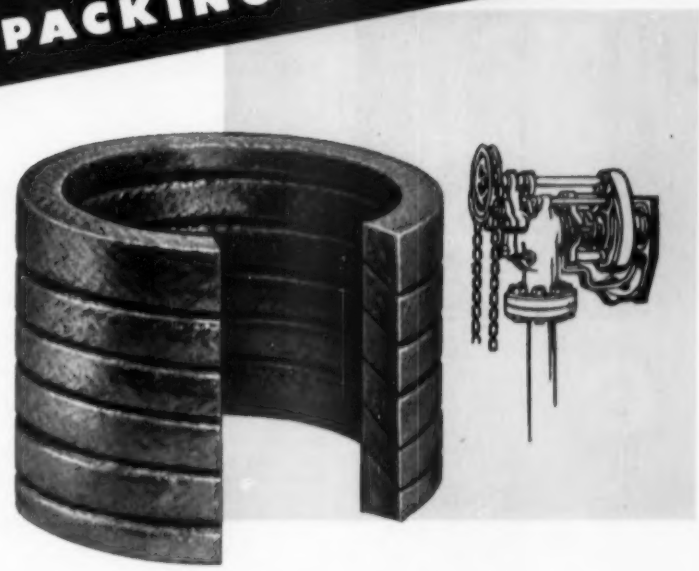
A SOOT BLOWER PACKING PROBLEM



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Results: Over six months of service, as compared to one or two weeks service from the rubberized fabric-type packing formerly used.

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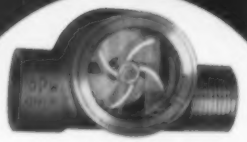

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are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

258 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

259 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

PUMPS

260 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

261 Steam Pump Care — Bulletin G-2280, "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting. Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners. Worthington Corp.

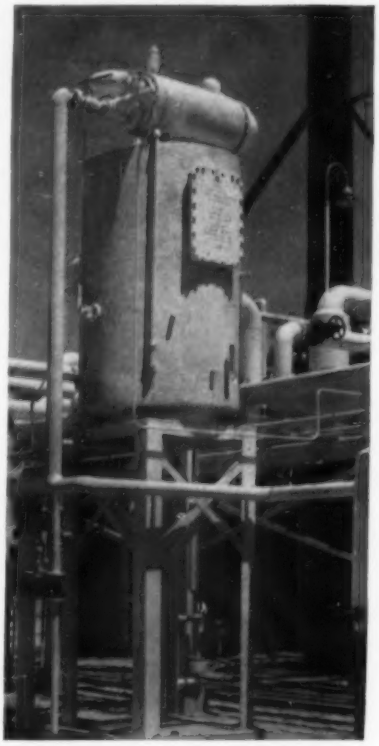
262 Meter that Pumps — Bulletin 300, 8 pp, describes company's improved meter that pumps — designed for precise metering and proportioning of small quantities of low viscosity fluids at low cost, over extended periods of time. Complete capacity tables and a detailed schematic are also included. Hills-McCanna Co.

263 Solids Handling Pumps — Bulletin 121-A, 8 pp, describes a complete line of non-clog pumps for handling solids in suspension. Included are vertical, horizontal and close-coupled types used to handle liquid components of industrial processes, industrial waste, and for such pumping applications as water supply, drainage and sewage handling. Specifications are included. Aurora Pump Div., The New York Air Brake Co.

PACKINGS, SEALS

264 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information.

How to solve a feed water problem



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265 Mechanical Seals — Bulletin S-205-2, 8-pp, covers the complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases. Provides construction, service and application information, installations and engineering details. Crane Packing Co.

FUEL BURNING EQUIPMENT

266 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

267 Oil and Gas Burners — Bulletin OB-53 28 pp gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

268 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

REFRACTORIES, INSULATIONS

269 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for efficient control of temperatures from −400 F to 3000 F. Johns-Manville.

270 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

271 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-p illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

OTHER EQUIPMENT

272 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propul-

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273 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multi-stage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

274 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

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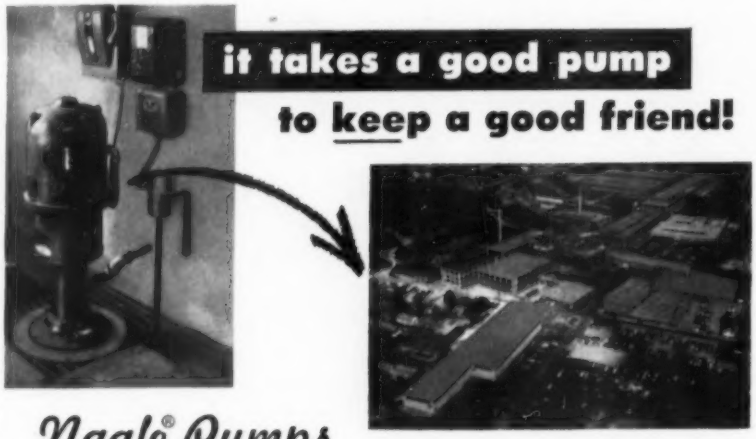
275 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

276 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Tables give design data for six sizes, from three to 20 tubes. Research-Cottrell, Inc.

277 Sectional Condenser — Bulletin 131 shows benefits of sectional-design refrigeration condensers for 100 to 240 tons refrigeration capacity and explains their functions with diagrams and installation photos. A cutaway shows component parts. Niagara Blower Co.

278 Heavy Duty Fans — Eight-pp Bulletin 4824 describes new Airfoil centrifugal fans for heavy duty industrial applications. Discusses performance features and construction details of the fans. Text is supplemented with photos and drawings of wheel, housing, bearing, shaft. Several possible volume control methods that can be used with these fans are described and evaluated. Brake horsepower curves for four volume control methods are included. American Blower Corp.



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NEW ENGINEERING BOOKS

Heat Power Fundamentals, by C. M. Leonard and V. L. Maleev. Size 6 by 9, 526 pages, including index, cloth binding. Published by Pitman Publishing Corp., New York, N. Y. Price $7.00.

This second edition is a thorough revision of the original printing. The main purpose of the book, however, which is to serve as a text for students who are taking their first course in heat-power engineering, remains unchanged but many chapters have been rewritten and others partly revised. In line with the fundamental purpose of the book, the fundamentals and ground work of the subject are covered in detail and with clarity. This is a complex text and discusses the entire range of heat-power engineering. In addition to the vapor power plant cycle which includes the generation of steam and its use in steam engines, steam turbines, there are separate chapters dealing with the internal combustion engine, gas turbine power plants, and mechanical refrigeration.

Affixed to the inside back cover of this book is a specially prepared Mollier chart.

This text can be recommended for those who have had little formal engineering training and wish to learn the fundamentals of power engineering.

* * *

Industrial Electricity — Vol. I. Direct Currents, by Chester L. Dawes. Third Edition, 1956. 431 pages, 6¼ by 9¼, cloth. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. Price $5.50.

This is the latest edition of a textbook originally published in 1924. It has been revised to bring it up to date and to make it more suitable for use at the technical institute level. This has been done to help meet industry's demand for technically trained men with a sound knowledge of electrical principles and the ability to apply these principles to industrial situations.

All principles are explained simply and on the understanding that the student is meeting them for the first time. The mathematics and formulas in the book can be easily understood by anyone having high school mathematics and physics.

The text is most suitable for courses in technical institutes, some technical high schools, industrial training programs, and non-electrical engineering courses at the college level. It is also written to be easily understandable to the self-study user.

At the beginning of the book, the fundamental laws of electricity, electric currents, primary and secondary batteries, magnetism, and electrostatics are explained and developed. The theory so developed is then ap-

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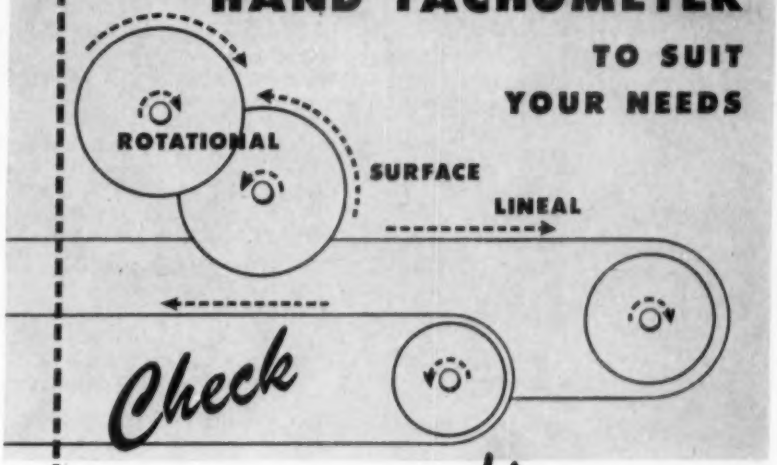

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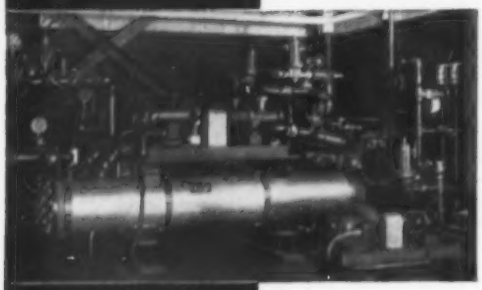

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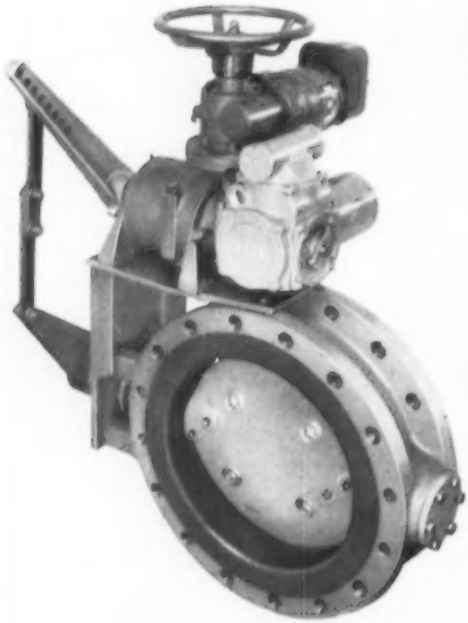

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Engineering Books

continued from page 115

plied in the second half of the book to technical and practical applications such as power distribution, electrical measurements, battery applications, industrial applications of magnetism, capacitors, and d-c generators and motors.

★ ★ ★

Mechanical Vibrations by J. P. Den Hartog. Fourth Edition, 1956. 436 pages, 6¼ by 9¼, cloth. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. Price $9.00.

This book is intended for junior or senior engineering students after the usual first course in statics, dynamics and strength of materials. It contains more material than is needed for undergraduates and so the latter half of the book may be used for graduate students, and the entire volume is valuable as a reference for practicing engineers.

As the distinguished author points out, while in 1934 a mechanical engineer was considered well educated without knowing anything about vibration, now such knowledge is an important requirement.

The book aims to be as simple as is compatible with a reasonably complete treatment of the subject of mechanical vibration. Mathematics has not been avoided, but in all cases, the mathematical approach used is the simplest one available. The book was originally published in 1934 and this is the 4th edition. In this edition the number of problems have been substantially increased, new material has been added on Kármán vortices and on nonlinear vibrations, with examples of cases that have appeared in practice since 1947. In addition, all chapters have been revised to bring the subject matter up to date.

★ ★ ★

Fundamentals of Vibration Analysis, by N. O. Myklestad. First edition, 1956. 260 pages, 9¼ by 6¼, cloth. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. Price $6.50.

This book is designed primarily for a first course in vibration analysis at either the undergraduate or graduate level. In addition, it is an appropriate text for training purposes in industrial organizations engaged in the manufacture of aircraft, engines, turbines, or any mobile equipment.

The book aims to give the reader a thorough understanding of vibrations from a basic point of view rather than by presenting routine methods of analysis.

Numerous examples of problems help the reader to understand the methods of analysis used in the text. The unusually large number of problems, many of which are answered in the back of the book, make this text useful for practicing engineers as a reference or for self study.

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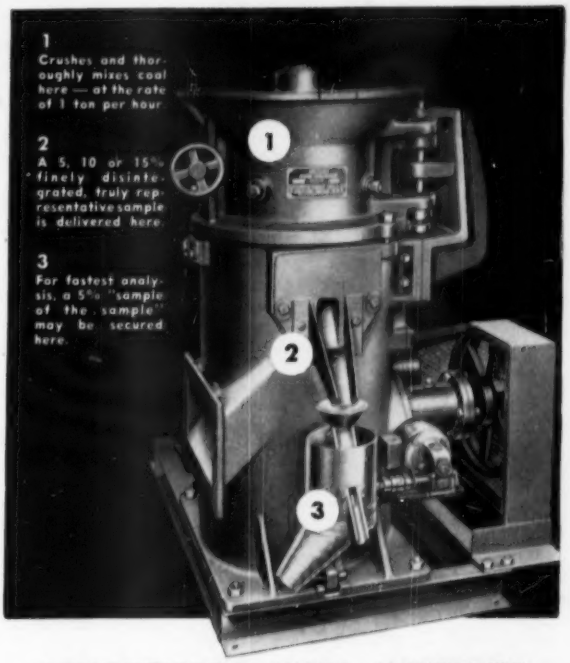
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Engineering Books

continued from page 116

tion, the subject of transient vibration has been treated in considerable detail. The second half of the book deals with systems of more than one degree of freedom and here too large a number of problems have been introduced to help the reader understand the subject.

* * *

Power System Stability, Vol III: Synchronous Machines, by Edward Wilson Kimbark. First Edition, 1956. 322 pages, 9¼ by 6, cloth. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price

This is the 3rd volume of a three volume work on power system stability intended for use by power system engineers and by graduate students. It grew out of lectures given by the author at Northwestern University in graduate evening courses.

Vol I, which appeared in 1948, covers the elements of the stability problem; the principal factors affecting stability, the ordinary simplified method of making stability calculations, and illustrations of the application of these methods in studies which have been made on actual power systems.

Vol II, which appeared in 1950, covers power circuit breakers of protective relays and the influence of these devices on power system stability.

Vol III, the present one, deals with the theory of synchronous machines and their excitation systems, an understanding of which is necessary for the justification of the simplifying assumptions ordinarily used in stability calculations and for carrying out calculations for the extraordinary cases in which greater accuracy is desired than that afforded by the simplified methods. This volume discusses such effects as saliency, damping, saturation, and high-speed excitation. It thus endeavors to give the reader a deeper understanding of power system stability than that afforded by Vol I alone.

Vol I should be considered a prerequisite to volume III.

* * *

Neutral Grounding in High-Voltage Transmission by R. Willheim and M. Waters. First Edition, 1956. 669 pages, 8¾ by 6¼, cloth. Published by the Elsevier Press and distributed in this country by D. Van Nostrand Co, 120 Alexander St, Princeton, N. J. Price $15.00.

This monumental work is the first book to appear in the English language which treats comprehensively and critically all methods of neutral grounding and other measures designed to reduce the fault rate on high voltage transmission systems.

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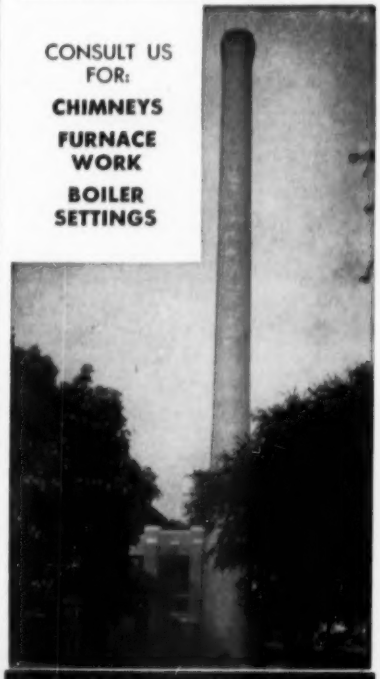

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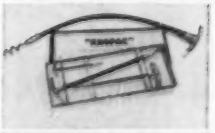

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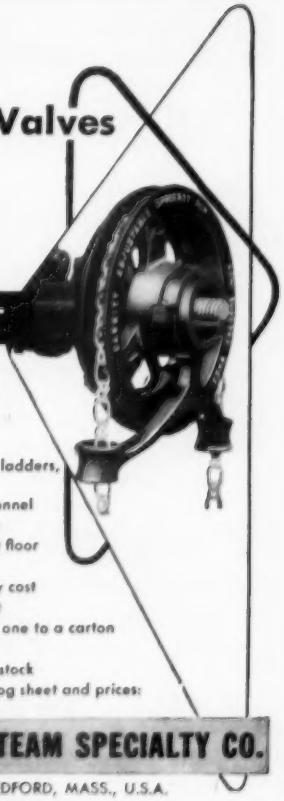

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HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 1 OF A SERIES)

Aerators, Degasifiers, Deaerators

If you want to remove dissolved gases or iron or taste and odor from large quantities of water, you will probably use aeration or degasification as part of the treatment.

Modern equipment for putting air or gases into water or taking them out is highly specialized, ranging from simple, low cost aerators to complex, highly efficient degasifiers.

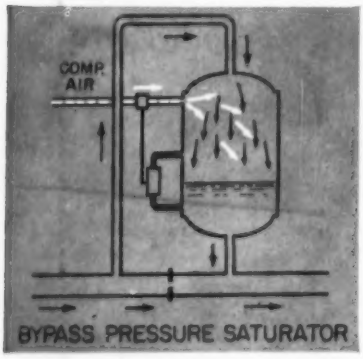
The following descriptions may help you choose the type of equipment that best solves your problem at the lowest cost.

To introduce air

If your problem is simple introduction of air to oxidize iron or manganese, **pressure aeration** may be preferred to avoid repumping. But introducing air into water under pressure can result in supersaturation when the pressure is reduced, causing "milky water" and filter troubles from air binding or upset beds.

A Bypass Pressure Saturator automatically provides aeration without the danger of supersaturation by introducing air to only a predetermined portion of the total flow. (Patented by Permutit.)

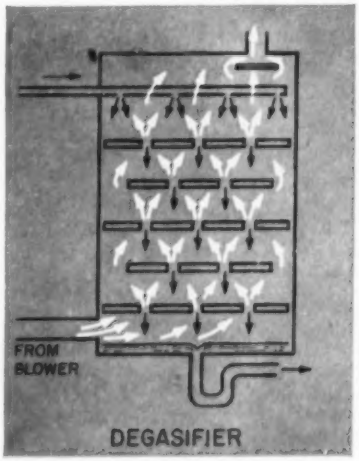
If you want to reduce CO_2 or taste and odor or accomplish any of these at the same time that you oxidize iron or manganese, an **aerator** is recommended.



Aerators may be of the open type in which water cascades over trays of graded coke or a series of wood slat trays. Splash aprons reduce splashing, permit free circulation of air. Formation of iron or manganese film on coke surfaces hastens oxidation reactions. Some reduction of CO_2 may also take place, raising pH and further helping oxidation.

To remove dissolved gases

For practically complete removal of CO_2, methane, hydrogen sulfide or other gases, the most efficient way is by a **degasifier.**



In a degasifier, water rains down through Raschig rings or wood slat packing countercurrent to a large flow of air from a blower. Thus the freshest air contacts the effluent water, gives lower final gas content. Proper packing design breaks water into thin films, promotes rapid and efficient gas removal.

Degasifiers are totally enclosed, avoiding splashing and spray losses. Outer tank may be of wood, rubber-lined steel, stainless steel or aluminum. Cylindrical units are usually more economical, but square or rectangular shapes may be used. Sizes and capacities are practically unlimited, depending on requirements. Units can be used for water with CO_2 as high as 3500 ppm.

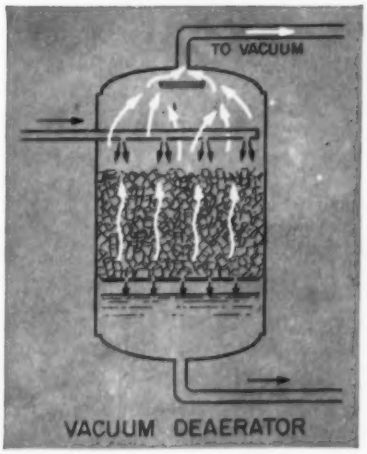
Although degasifiers provide very complete aeration, their higher cost is unwarranted in many cases where simple introduction of air is the main objective.

To remove oxygen

If you want to remove oxygen without heating the water, use **vacuum deaeration.**

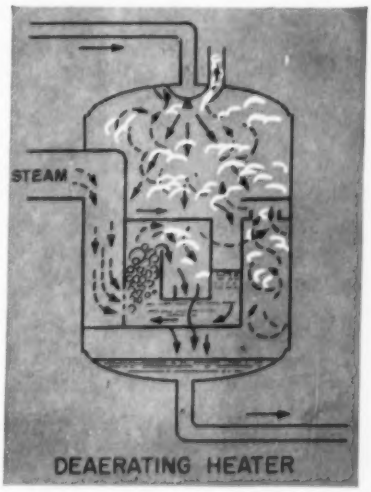
A vacuum deaerator is a steel tank lined where necessary and containing suitable packing such as Raschig rings. A vacuum is maintained in the tank by steam jet ejectors or motor-driven vacuum pumps. Under a vacuum, solubility of gases in water is greatly lowered. As the water trickles down through the packing, the gases present, including oxygen, nitrogen and carbon dioxide, are liberated and drawn off. Type and depth of packing, degree of vacuum, flow rates and other variables must be accurately adapted to your specific conditions for best efficiency.

If the water is to be heated as for feeding boilers, a vacuum is not necessary, and a **deaerating heater** is recommended.



In a spray type deaerating heater, the water is first sprayed through steam which removes most of the non-condensable gases. (The gas-laden steam is condensed and vented.) The water is then reboiled by passing steam through it for final deaeration.

Where less complete removal of oxygen is required, the reboiling (scrubbing) stage may be omitted.



For detailed information on these or any other types of water-conditioning equipment, write: The Permutit Company, Dept. PE-3, 330 West 42nd St., New York 36, N.Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

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